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# Engineering News-Record

*A consolidation of Engineering News, Engineering Record The Sanitary Engineer, and The Contractor*

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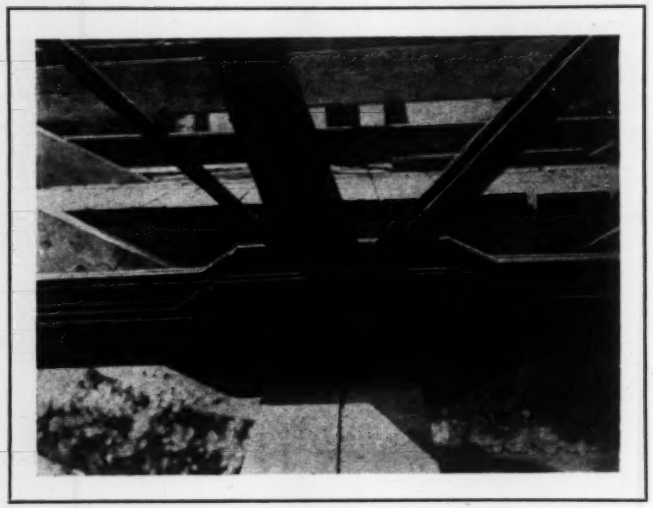

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# Engineering News-Record

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# Three-Level Rail and Road Crossing

**Layout in Newark, N. J., features a compact combination of structures, including a flat-slab railroad bridge of unique design with a 32-in.-thick slab in panels 28x35 ft., a main state highway on the lowest level and a park drive carried overhead on a concrete rib arch having skeleton abutments**


By A. Burton Cohen
*Consulting Engineer, New York, N. Y.*


TWO BRIDGES, one built over the other to form a crossing of three separate levels for two highways and a main-line railway, have recently been built through the joint participation of the Essex County Park Commission, the Lehigh Valley Railroad and the New Jersey State Highway Commission in Weequahic Park, Newark, N. J. The bridges consist of a reinforced-concrete highway arch of 122-ft. span carrying a park drive over the railroad and a flat-slab reinforced-concrete railroad bridge that passes over a main state highway. In the composition of the railway bridge there is a distinct departure from the conventional type. Among the features may be mentioned a floor slab with unprecedented size of panels, 28x35½ ft., and a thickness of 32 in., entire elimination of gravity abutments and the use of a so-called "depending" slab, hung at right angles to the floor slab, which is cantilevered beyond its end supports. This depending slab takes a major portion of the lateral thrusts of the earth backfill and surcharge of live load thereon and, because of its own weight

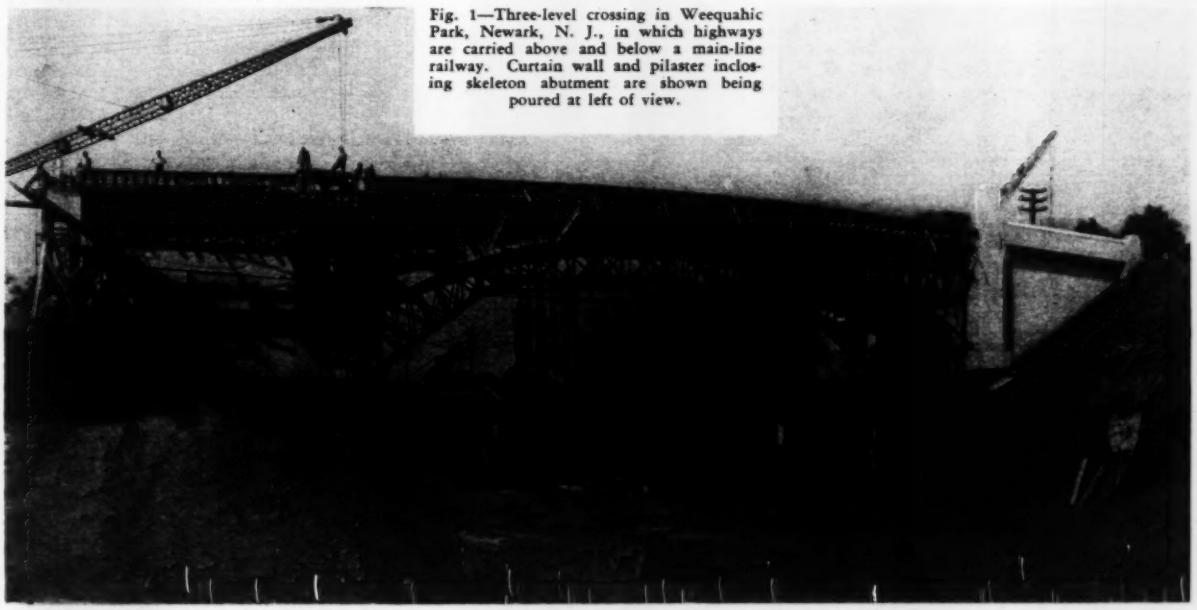


**Fig. 1—Three-level crossing in Weequahic Park, Newark, N. J., in which highways are carried above and below a main-line railway. Curtain wall and pilaster inclosing skeleton abutment are shown being poured at left of view.**

and position it helps to balance column moments from eccentric loading and to reduce slab moments.

The structure is situated about eight-tenths of a mile west of the Meeker Ave. station of the Lehigh Valley Railroad in the city of Newark, where a structural-steel deck girder bridge has for about 30 years carried a 20-ft. drive in Weequahic Park over the railroad tracks. In the vicinity of this bridge it was found necessary to project the new state highway, Route 29, under the rail-

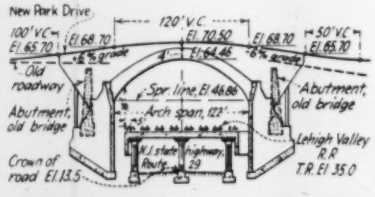



**Fig. 2—Layout of structures in three-level crossing, showing elevations and clearances.**

road tracks to effect a crossing. Studies revealed it to be most economical to make the crossing at the bridge, at the same time replacing the old bridge with a reinforced-concrete arch. The result was a three-level layout centered about the intersection of the center lines of the railroad and the two highways. While the center lines of the railroad and park drive arch are at right angles to one another, the undercrossing is on an angle of 28 deg., with the center line of the railroad (Fig. 3).

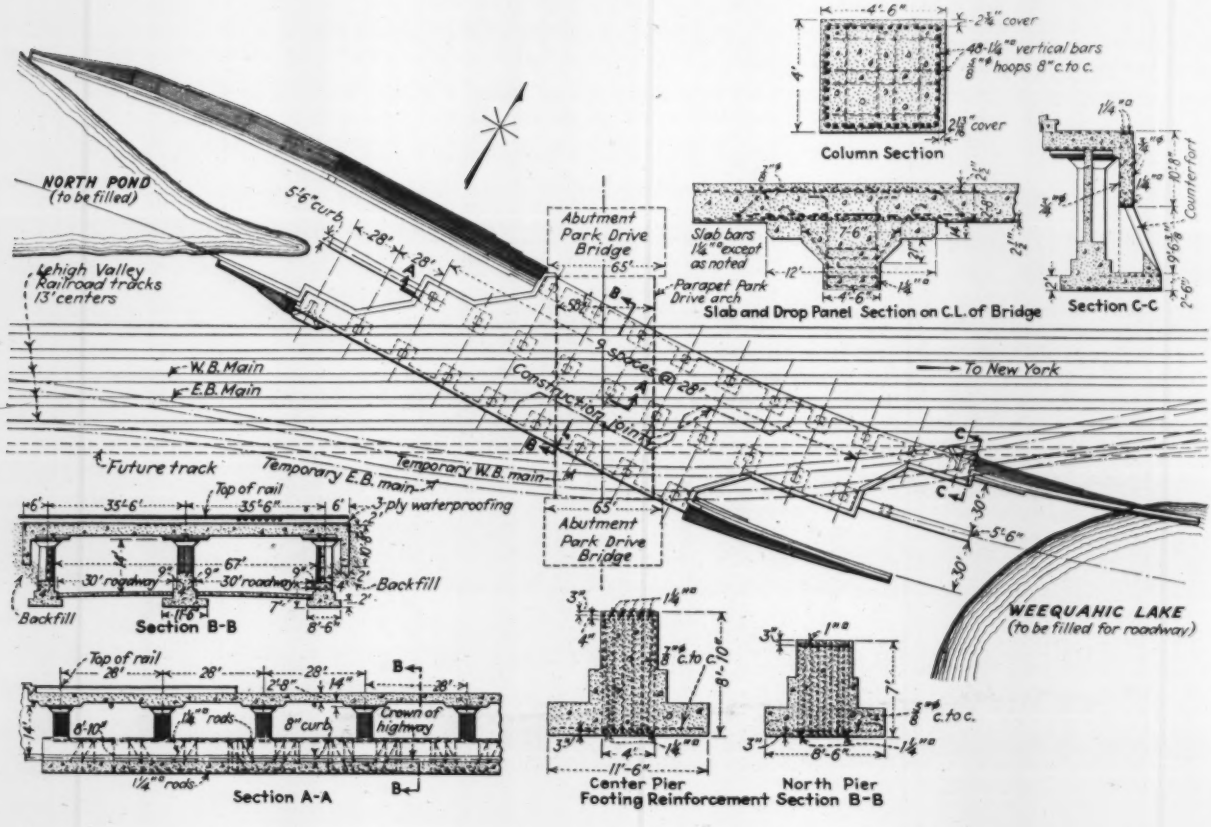
In the evolution of the design of the two structures an effort was made to create a definite simplicity in construction, combined with a pleasing architectural treatment and, in the composition of the design, to proportion the structural parts for effective use of all material. The results obtained in molding the parts to fit the extraordinary combination of conditions exemplify the inherent adaptability of reinforced concrete for either railway or highway structures.

## The flat-slab railroad bridge

The flat-slab bridge was built over two separate one-way 30-ft. highway lanes composing Route 29. Transversely, a two-span slab has for its intermediate support a line of columns located along a center safety isle, 5½ ft. wide, which is carried for a considerable distance beyond the portals of the bridge as an indication of the two-lane division of the highway around the approach curves and through the undercrossing.

The principal feature in the design of the flat-slab bridge is the elimination of the massive gravity-type abutments used in similar undercrossings for end support of the floor deck. These are replaced by curb-line column bents, which give to these exterior panels of the two-span flat slab a plate action comparable to the action of interior panels in continuous spans. The 4-ft.-wide columns, set back 9 in. from the curb, fixed the length of the transverse panel span, c. to c. of columns, at 35½ ft. In the longitudinal direction there are ten columns spaced 28 ft. c. to c. along the center bent. These large panels, 28x35 ft., require a slab thickness of 32 in., exclusive of the 14-in. drop-panel. At the exterior columns a full drop-panel was used, and the slab was carried 6 ft. beyond the column center lines. Also a depending slab, 10 ft. 8 in. deep, including floor-slab thickness, was cantilevered from the floor slab, forming a back wall to resist the major portion of the horizontal thrust due to the earth backfill and surcharge live load. This depending slab, with that portion of the floor slab extending beyond the center line of the columns, forms a reinforced-concrete angle of considerable stiffness and torsional restraint, gives balance to column moments due to eccentric loading, reduces slab moments and adds to the stability of the columns by precluding earth pressures therefrom. Functioning with the depending slab, there is an inverted continuous T-beam footing that carries the columns. This footing projects above the roadway surface to give minimum foundation excavation and to take that portion of the horizontal earth pressure and surcharge live

**Fig. 3—Notable flat-slab railroad bridge utilizes panels 28x35½ ft. in plan and a 32-in.-thick slab that is carried beyond the end supports and bent down, thus holding some of the backfill and reducing column and slab moments.**



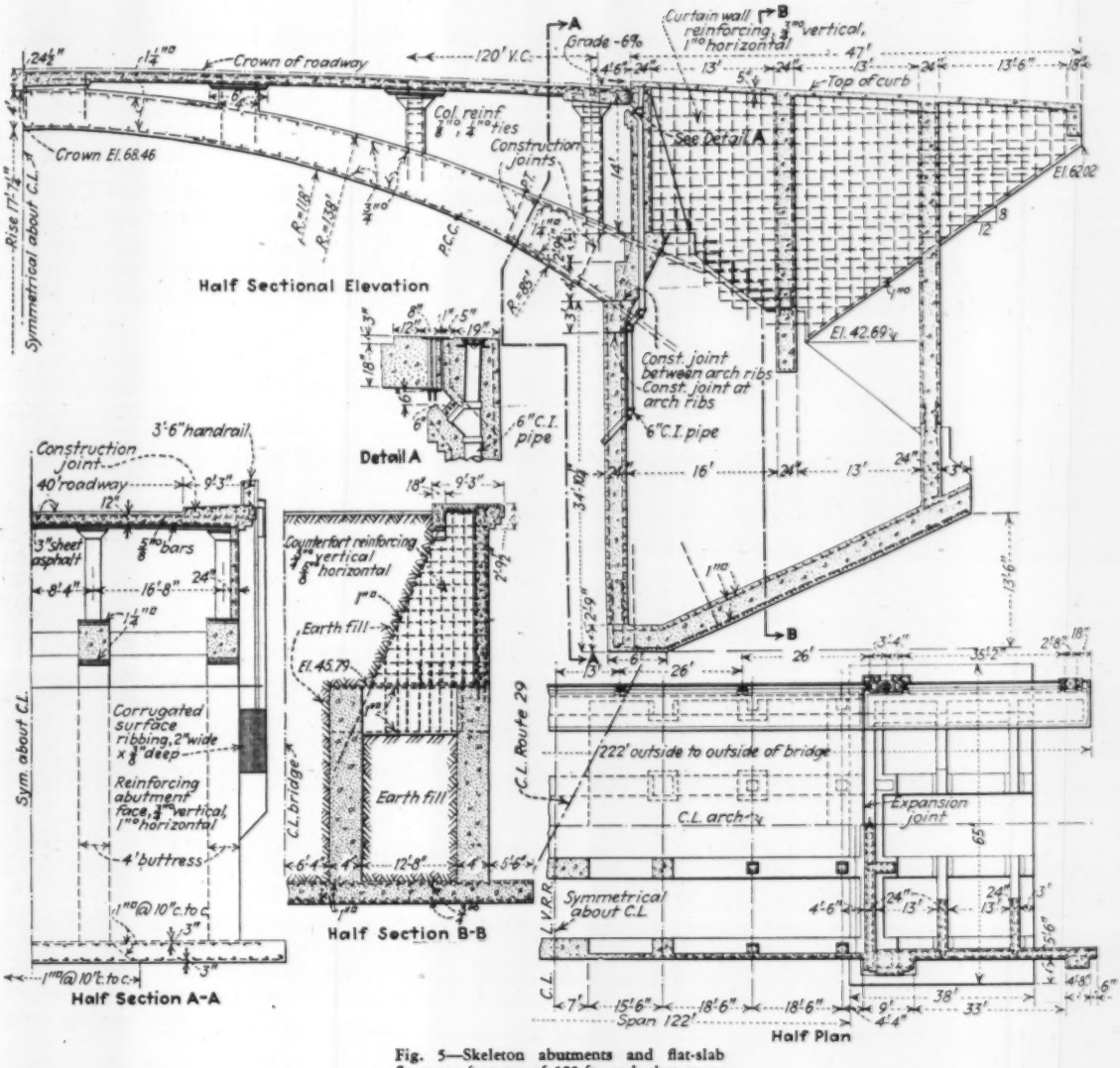



**Fig. 5—Skeleton abutments and flat-slab floor are features of 122-ft. arch that spans the railroad bridge and highway underpass.**

load that is not resisted by the depending slab. The slight overflow of the backfill between the bottom of the cantilever back wall and the top of the footing beam is held by a 12-in. curtain wall between the columns, extending up to the bottom of the column capitals. The footing beam reduces the columns to short pedestals, adding to the stiffness of the fixed support. Its base, 8½ ft. wide, is designed to carry a 3 ton per sq.ft. maximum foundation reaction over its entire length. The friction resulting from this direct foundation load resists the sidewise lateral thrust against the footing.

Despite the skew of the bridge it was possible to space the columns to obtain rectangular panels throughout, with the exception of two triangular panels at either end. The end curb column supporting the triangular panel is located directly under the outside track. In this position it is advantageously located with respect to minimizing the effect of the live load on this triangular end panel, but furnishes of itself insufficient means for projection of the slab to obtain support for the parapet. This support was provided by adding a lone column to the curb bent, over which the slab was continued for a width only of a direct band of reinforcement. This one-way reinforced slab panel carries coping, parapet, a very small increment of live load and the suspended back wall. Since the balancing effect of at least one full rectangular slab panel is missing to counteract the earth pressures against this extended section, the flange of the inverted T-beam footing was projected beyond its normal width to secure retaining-wall composition. Two diagonal counterforts were then cast integral with the end column and anchored to the extended footing (Fig. 3).

The particular phases of flexibility of concrete, so well adapted to the framing of this structure, are to be found in the adjustment of those parts built to the curve alignment and to grade. The forms for the depending slab and the inverted T-beam footings, having parallel sides, were easily shaped to the highway curvature; the transverse center lines of the columns were placed on radial lines. Also the slab of uniform thickness was placed parallel with the 0.24 per cent grade of the railroad, permitting ballast of practically uniform minimum depth.

Points of secondary interest in the make-up of the railroad bridge include the waterproofing, drainage and lighting. The uninterrupted flat surface of the bridge slab was easily waterproofed by a built-up membrane of three plies as asphalt-saturated cotton cloth laid up in four swabbings of hot asphalt. Invulnerable terminations of the membrane were made in 3-in. recesses, 2 ft. in depth, formed along the top of the cantilever back walls and in similar vertical recesses along the inner face of the parapet walls. On horizontal surfaces the membrane was protected from the stone ballast with a covering of asphalt paving plank, also swabbed with hot asphalt. Abrasion was prevented on vertical membrane surfaces by a layer of common brick laid in cement mortar. All surfaces of the structure in contact with backfill were given two coats of emulsified asphalt. As to drainage, the

projection of the slab beyond the column line permitted easy disposition of the water in the earth embankment.

There are only four full two-span panels, of 112-ft. total length, where no daylight is available from the side. A dual system of lighting was installed—system *A*, composed of seven lights, will burn on dark days and system *B*, including fifteen lights, will burn during the night.

The structure was designed to carry a Coopers E-70 engine loading, which was found to give an equivalent uniform loading of 800 lb. per sq.ft. in continuous beam action over the average span length of the rectangular panels. The average impact increment for the slab was 63 per cent of the live load. Impact was also considered in the column but not in the footing beam design. The slab is reinforced in a four-way system, with direct and diagonal bands composed of 1¼-in. square bars crossing the full width of the column drop-panel and with a major number bent up over the columns to take the negative moment.

Columns are rectangular and designed for the direct load and moment resulting from a full and partial loading on the structure. The vertical reinforcement is 4 per cent of the area and consists of 1¼-in. square bars.

The projecting stem of the footing beams has the same width as the columns; and the depth of the beam, uniform for the entire length of the pier, was determined by the maximum moment resulting from a rational distribution on the soil of the column loads under full or partial loading of the structure. Bars 1¼ in. square comprise the principal reinforcing.

The contract was awarded on a unit-price basis covered by fifteen items, six of which were items of concrete. An extra unit price was obtained for 5,000 bags of cement to provide for any additions that the engineer would require to obtain special results as to workability, including consideration of variable temperatures.

Of primary importance was the preliminary estimate of cost of the flat-slab bridge as compared with the estimate of cost of an uncased steel girder and I-beam floor system supporting a concrete-slab deck. The assumed center support for the latter construction was a multiple-arch concrete bent with continuous footings, while gravity abutments formed the end supports. In this comparison the flat-slab bridge showed a saving in first cost of 25 to 30 per cent.

### Park drive arch

The park drive arch supports a 40-ft. roadway and two 8-ft. sidewalks on four 4-ft.-wide ribs spaced 16 ft. 8 in. on centers. Rib construction was chosen as being more economical and efficient than a barrel-arch design for a span of 122 ft. A flat-slab floor is one of the distinguishing features of this bridge, as it is of the railroad span. Panels are 16 ft. 8 in. by 18 ft. 6 in., the floor being three panels wide across the bridge and three panels long on either side of the crown of the arch. The panels are designed to carry a 15-ton truck or an equivalent uniform load of 370 lb. per sq.ft., including an excess of 35 per cent for impact. The full arch span was designed for a uniform live load of 125 lb. per sq.ft., including an impact factor.

The slab is 12 in. in depth, reinforced four ways with ⅝-in. round rods. It was bent to the shape of the vertical curve of the roadway in its longitudinal direction and to the crown of the roadway transversely. The ability to warp the slab in this manner proved a considerable advantage and effected economy over any possible arrangement with a girder and beam floor. The only slight excesses in depth of slab occurred where the under side was formed along chords to curves between edges of the 6x6-ft. drop-panels over the columns. The floor slab was extended to the face of the parapet, providing the same strength over the sidewalk as over the roadway, so that a vehicle can mount the sidewalk without causing structural damage.

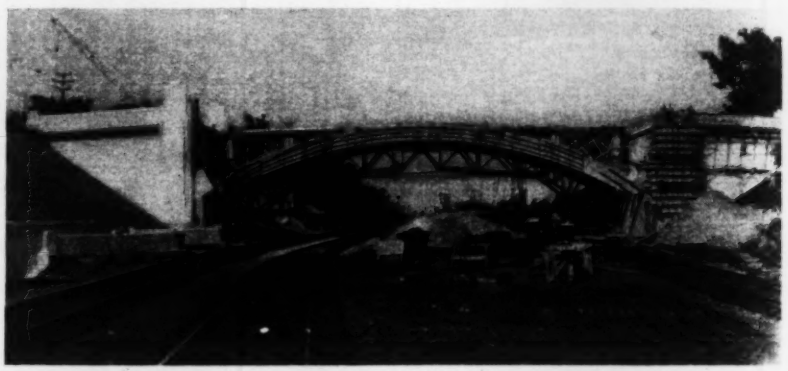


Fig. 6—Three-level crossing was built without interrupting railway traffic. Steel centering, two trusses per rib, was used for constructing the park drive arch. Embankment at left is completed, while at right skeleton nature of abutment is apparent.

The lower parapet coping offset was made a part of the floor slab, while the upper section was cast with the sidewalk slab, which was laid directly on the floor slab immediately after it was poured. The floor surface in contact with sidewalk concrete was treated to expose the aggregate, remove laitance and thus insure a good bond. To prevent percolation of roadway surface water through this construction joint, a dike 4 in. high was formed integral with the floor slab 1 ft. back of the face of the curb. This dike contained a copper flashing that projected into the sidewalk slab. In contrast to this side joint, the cantilever expansion joint at either end of the slab at the abutments was not designed to exclude all of the water passing over, since in the shallow floor depth it would be rather difficult to seal the opening. The joint therefore was covered by a plate, bolted to the slab on the uphill side of the opening and free on the downhill side to permit expansion. Provision was made to intercept any water percolating through this joint by catching it in a trough formed in the coping overhang of the face wall of the abutment and discharging it from a 6-in. cast-iron downspout leading from the trough to a level below the tracks.

The arch abutment is skeleton in form and includes four buttresses in line with the arch ribs and of the same narrow width, whose loads are distributed over a gravel bed by a continuous inclined footing slab placed approximately normal to the line of buttress pressure. To insure no disturbance to the foundation grading while the workmen were placing the steel reinforcement for this footing slab, a 4-in. concrete sub-base was placed upon the incline immediately after it was brought to true grade. By this expedient the placing of the reinforcement was accomplished both more easily and more accurately.

Curtain parapet walls with their soffit 3 ft. below and parallel with the earth-fill were built on the outer buttresses of the abutments and anchored to the interior buttresses by counterforts carried on cross-beams poured integral with the buttresses and connecting them in pairs. The walls are cantilevered 15 ft. beyond the last counterfort, which is on the heel of the buttresses. The top of this counterfort was given sufficient width to support a curb beam, which also was cantilevered and braced across the end to furnish more lateral stability to this end section. The sidewalk slab was poured integral with the coping overhang and the curb beam.

The entire work was divided into 24 items, and unit prices were obtained for each item. Cement was separated from the unit price of the concrete, permitting the engineer, under definite contract, to vary the amount of cement to obtain special results as to workability, including the consideration of variable temperatures. The proportion of the fine to the coarse aggregate could also

be varied by the engineer without disturbing the unit prices of the eight different items of concrete.

The railroad bridge was built in two stages about the construction joint through the slab, as shown in Fig. 3. The old park drive bridge was dismantled first, and two detour tracks for main-line operations were laid outside the existing track layout, partially on new fill, to clear the construction of the first stage. The north abutment of the arch bridge was built with the first stage of the railroad bridge. All excavation was made with a power shovel. Upon the completion of the first stage of the railroad bridge, main-line track operations, were shunted over the two permanent northerly tracks laid on the deck of the finished portion. Then followed the excavation for the second stage.

Meanwhile the south abutment of the arch bridge was constructed with all possible speed to the skewback elevation, so that the arch bridge could be hurried to completion. For each 4-ft. concrete arch rib a single-span two-truss structural-steel centering of the three-hinged arch type was used, erected on concrete corbels built integral with the abutment buttresses and at the level of the subgrade of the railroad.

Two arch ribs were poured together, beginning at all four haunches and working uniformly and continuously toward the crown, with the exception of 8-ft. keys adjacent to the abutments, which were poured last. The arch rib steel reinforcement was given a free lap in the key, so that the bars could slide along each other during deflection of the centering and thus eliminate a restraint that would tend to crack the freshly poured concrete.

The full-span centering made possible the construction of the second half of the railroad bridge along with the ribs and superstructure of the arch. Main-line railway traffic was of course uninterrupted.

All forms for exposed surfaces of the arch bridge were lined with plywood. Very little rubbing was necessary to remove joint marks. The concrete was poured with practically no honeycombing. A 3 per cent admixture of finely ground talc was used in the concrete.

### Engineering direction

The railroad bridge work was carried on under the direction of G. T. Hand, chief engineer, Lehigh Valley Railroad, assisted by W. R. Johnston, engineer of grade-crossing eliminations. W. H. Ramsey was resident engineer in charge of construction. The arch bridge work was directed by J. H. Philips, chief engineer, Essex County Park Commission. J. C. Malay was resident engineer. State of New Jersey supervision was given through the office of Jacob L. Bauer, state highway engineer. The plans were developed in the office of the writer, collaborating with H. T. Rights, bridge engineer, Lehigh Valley Railroad, in the railroad bridge design. H. K. Wilson was principal assistant in design of both structures. The Rust Engineering Co., Pittsburgh, built the structures under separate contracts, which were coordinated with respect to construction.

# Over-a-Minute Mixing Adds No Strength

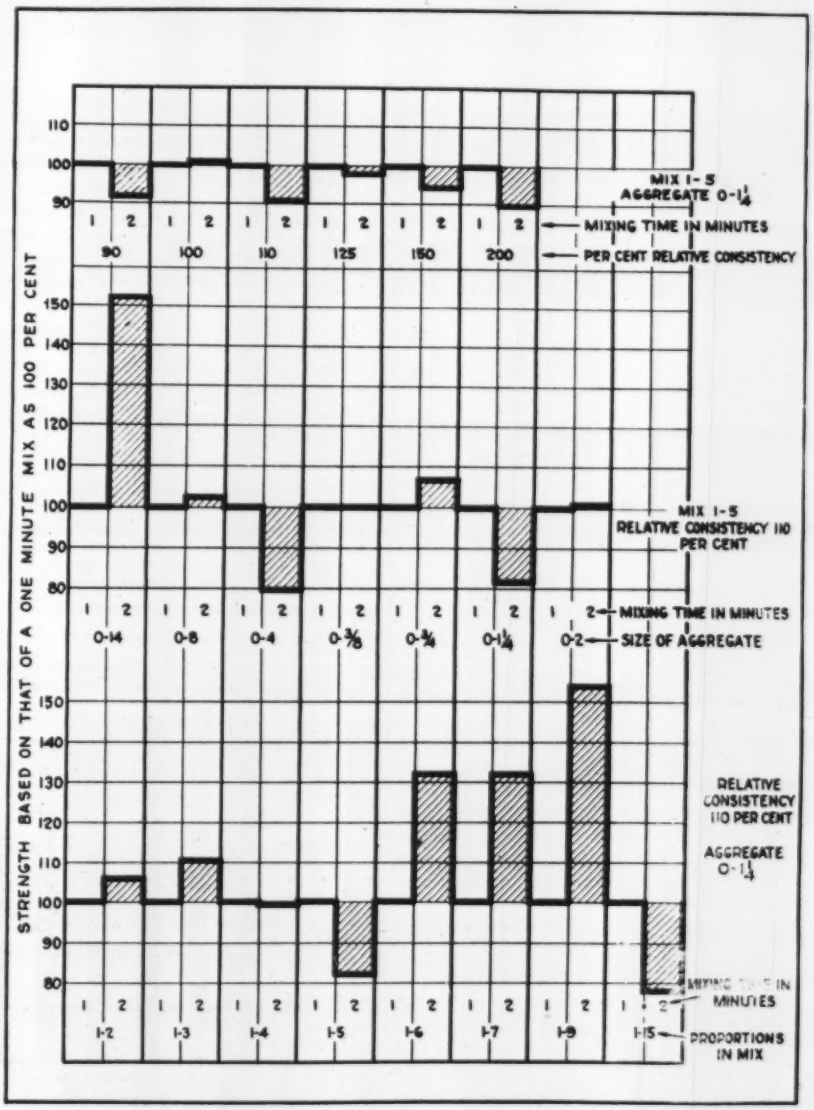
## Cylinder tests of field concrete made this year by Nashville Engineer District show no material gain in strength by increasing mixing time to two minutes

By F. S. Besson

*Major, Corps of Engineers; District Engineer, U. S. Engineer Office, Nashville, Tenn*

SOME of the concrete specifications at present in force in the United States call for a mixing period of 1 min., while others call for greater periods, with 2 min. the limit found in many specifications. In some few instances large mixers, on the basis that they are not so efficient as small ones,

Fig. 1—Difference in strength, 1- and 2-min. mixes, Duff Abrams' tables. Each record is of a single batch, four cylinders per batch, age 28 days.


STRENGTH BASED ON THAT OF A ONE MINUTE MIX AS 100 PER CENT
MIX 1-5 AGGREGATE 0-1¼
MIXING TIME IN MINUTES
PER CENT RELATIVE CONSISTENCY
90 100 110 125 150 200
MIX 1-5 RELATIVE CONSISTENCY 110 PER CENT
MIXING TIME IN MINUTES
SIZE OF AGGREGATE
0-1¼ 0-2
RELATIVE CONSISTENCY 110 PER CENT
AGGREGATE 0-1¼
MINUTES
PROPORTIONS IN MIX
1-2 1-3 1-4 1-5 1-6 1-7 1-9 1-15

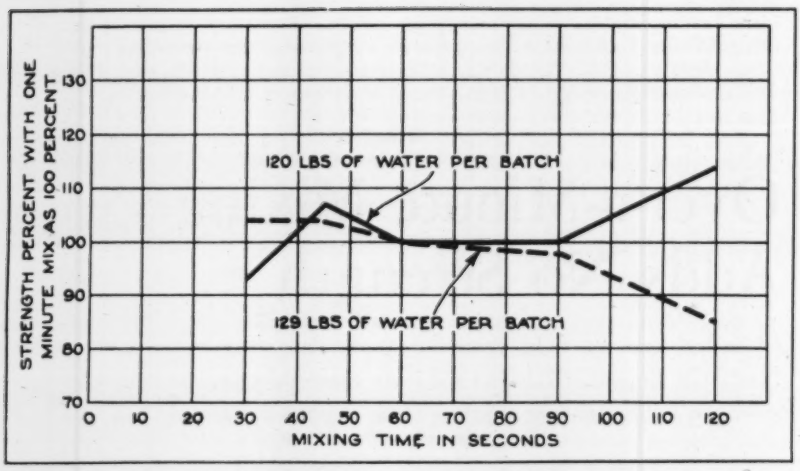



**Fig. 2—Data from Professor Hatt's Table I. Each record is the average of fifteen 28-day cylinders, three from each of five batches.**

are penalized under specifications that increase the mixing time from 1 min. with very small mixers to 2 min. with very large ones.

This discussion covers an investigation of mixing periods for concrete that the Nashville Engineer District made on a field job during the summer of 1932. In order to form a proper basis for procedure, the investigation included a study of tests and data made public by other investigators.

### Previous tests

The 2-min. practice was developed largely from the widely published paper that Duff Abrams presented to the American Concrete Institute in 1918. In this paper he shows strength curves continuously rising, from a ¼- to a 10-min. mix. Generally from 1 to 2 min. on these curves the strength increases are considerable. Above 2 min. the curves generally flatten in a pronounced manner. These two circumstances account for the 2-min. limit found in specifications.

If one interprets the data of Duff Abrams, not in a general fashion but with the aid of Fig. 1, one finds no justification for concluding that a 2-min. mix is superior to 1-min.

Data for Fig. 1 are taken from tables 7 and 8 of Abrams' report. Each 1- and 2-min. ordinate is the average of four 28-day cylinders taken from a single batch of a 3½-cu.ft. mixer. No two batches are similar. The variables are: amounts of water, varying from 90 to 200 per cent consistency; aggregates, varying from a 0-14 sand mix to a 0-2 sand-gravel mix; and proportions, varying from 1:2 to 1:15.

To find the law by which concrete varies with time of mixing, an investigator cannot take the average of a group made up of one sample of each of a number of other variables. A sand mortar may follow a different law from a gravel concrete, a dry mix may be different from a sloppy one, and a lean concrete different from a rich one. Tables 7 and 8 may be used for no other purpose, as far as time of mixing is concerned, than to compare isolated single batches.

The test just described cannot be decisive because it is well known that if, instead of the 2-min. batches indicated in Fig. 1, an investigator were to substitute 1-min. batches, it is within the limits of probability that he would obtain a figure exactly as here shown. An interpreter of Fig. 1 may not safely conclude that there is a trend either up or down between a 1- and 2-min. mix.

In 1921 Professor W. K. Hatt tested a 10-cu.ft. mixer at Purdue University. Table I of his report presents data covering two concretes that he carried through mixing periods from 30 sec. to 2 min. Each concrete was a 1:2:3 mix, with No. 4 sand and 1-in. gravel; the only difference in the make-up was the water content, which was 120 lb. per batch for one and 129 lb. for the other. Fig. 2 illustrates the outcome of the test.

Professor Hatt's test was very limited, containing only five batches per record; and for Fig. 2 an interpreter may safely conclude only that a 2-min. mix is shown to be no better than a 1-min. mix.

In 1924 Pope and McKesson, of the California highway division, tested on a construction job a 36-cu.ft. mixer, ten times as large as that of Duff Abrams. Their report appeared in the February, 1926 number of *California Highways*. The mix was 1:2:4, and the slump appproximately 2 in. Fig. 3 illustrates the results of the tests.

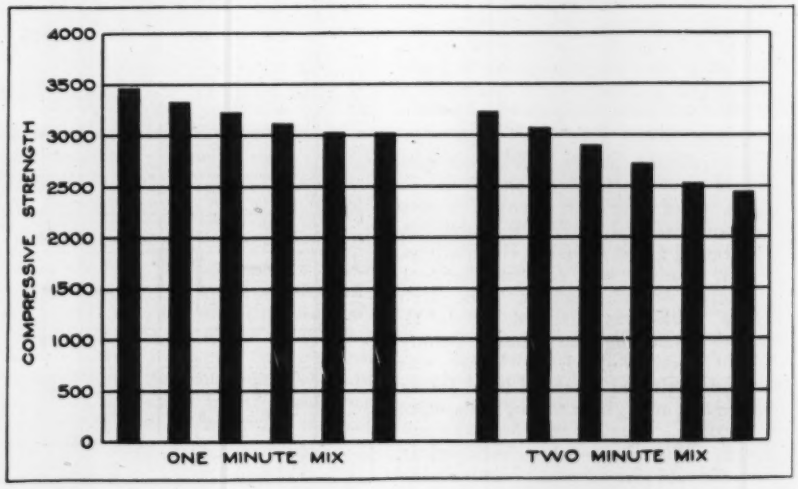
These California tests were also too limited to give definite results. The conclusions of Pope and McKesson were that for concrete, made approximately as is common on road work, no additional strength may be expected from the second minute of mixing.

In the July, 1928, number of the U. S. publication *Public Roads*, J. L. Harrison reports tests of five- and six-bag pavers. As a general rule the investigator took a single cylinder per batch after the paver deposited the concrete on the roadway.

In Table 29 Harrison presents data collected from four jobs: two in Oklahoma, one in Missouri and one in Michigan. While he gives data for other jobs, these are the only four on which he took a number of cylinders for each mixing time, 60, 75, 90 and 120 sec. Fig. 4 illustrates the results of these tests, based on a total of 158 cylinders.

Again there are not sufficient cylinders in each group of the test to give fair averages. An engineer might take samples of concrete, such as is habitually found on road work, and make 158 cylinders all representing a 1-min. mix. If he were to divide these cylinders haphazardly into twenty groups, he could in all probability duplicate the results shown in Fig. 4. It is safe to assume only that the tests do not show a 2-min. mix to be better than a 1-min.

**Fig. 3—California highway division's Table I. Comparison of 1- and 2-min. mixing periods. Each record is of a separate cylinder, two cylinders per batch, age 28 days.**




### Army tests

In reconstructing Dam No. 4, 40 miles above Nashville, Tenn., the Nash-

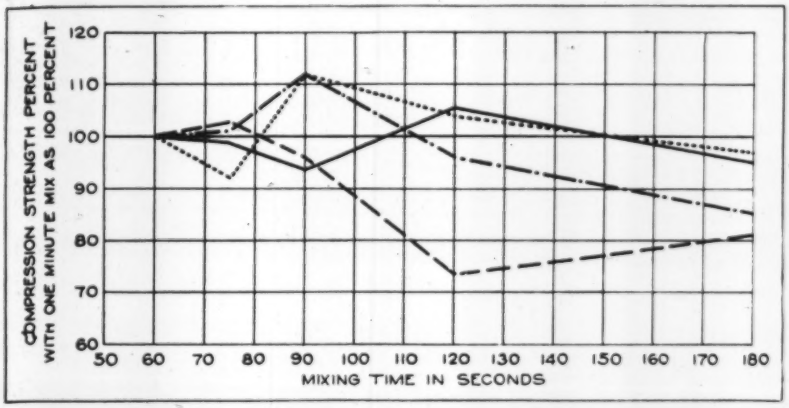



**Fig. 4 — Mixing-period comparison based upon four paving jobs presented in Harrison's Table 29. A total of 158 cylinders is distributed among five mixing periods. Age, 28 days.**

ville District used 28 cu.ft. of bar-run gravel and 6½ bags of cement per cubic yard of concrete.

The construction force used a battery of two ¾-yd. mixers, turning at 12 revolutions per minute. The mixers were in good repair, though each had been in service during five past working seasons. The loading skip charged each mixer with 14 cu.ft. of gravel and 3½ bags of cement per batch. Distribution was by bottom-dump buckets.

The water men could not charge the mixers with equal amounts of water for each batch for two reasons: (1) the gravel in the barges contained water in varying amounts; (2) uniform quantities of water could not be used because bar-run gravel is not as uniform a combination as is a mixture of screened gravel and sand. The engineer in charge permitted the water-cement ratio to vary as might be required to give an average slump of about 4 in. For the reconstruction of the dam satisfactory workability in the forms was all-important.

A review of tests made by others, the results of which review are presented in the early paragraphs of this discussion, was well justified in determining the steps that the Nashville District should follow. The testing forces should test each mixer separately, should maintain constant proportions and consistency and should test a sufficient number of batches to cover a complete cycle of variations.

Knowing that mechanical analysis would show variations in the aggregate grading, the engineer in charge knew that he would require a large number of cylinders to obtain a complete cycle of events. He decided that 500 cylinders per mixer, 250 for 1 min. and 250 for 2 min., would be sufficient to indicate the trend of the output.

The testing forces for each mixer alternated four 1-min. batches with four 2-min. batches throughout the duration of the job. They made, in accordance with A.S.T.M. standards, from one to three cylinders and slump tests from each four-batch alternation. This procedure gave four groups of tests:

Mixer *A*-250 cylinders, 1 min., 250 slump tests

Mixer *A*-250 cylinders, 2 min., 250 slump tests

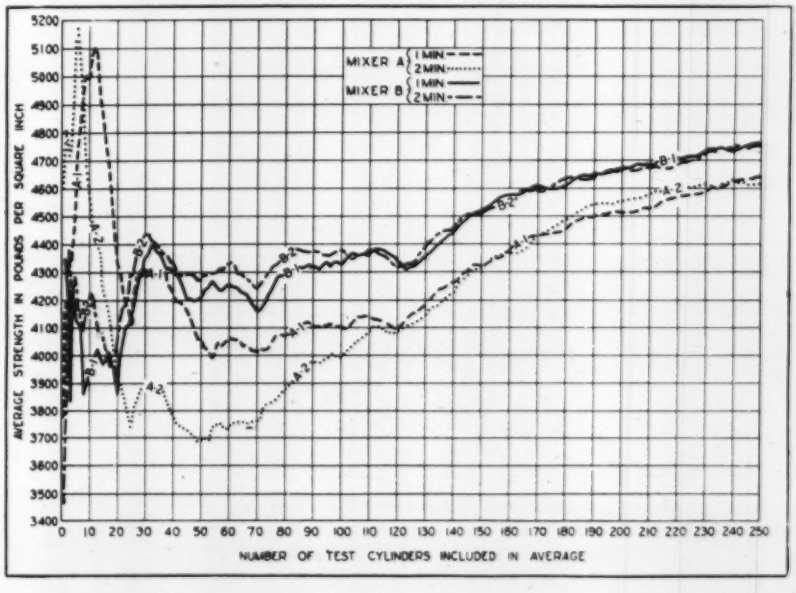
Mixer *B*-250 cylinders, 1 min., 250 slump tests

Mixer *B*-250 cylinders, 2 min., 250 slump tests.

The test data, illustrated in Fig. 5, show that a complete cycle exists with approximately 120 cylinders.

An engineer might take a number of cylinder records, representing successive tests from a short period of the job, and as is evident from Fig. 5 he might reach any conclusions whatsoever. But if he considers a number, greater than the number in a complete cycle, his evidence is true for any number however large. For example, between 120 and 250 cylinders, the 1- and 2-min. curves are practically identical.

**Fig. 5—Nashville District test of mixing periods. Two mixers, *A* and *B*, each tested for 250 1-min. batches and 250 2-min. batches, one cylinder per batch. Age, 28 days.**




It is interesting to note that mixer *B* turned out stronger concrete than did mixer *A*.

The curves are generally rising from 20 cylinders to the end of the test. The fact that in the early days of the job the dredge prospected in the bar until it found the best gravel pit accounts for this feature. With continued use of the pit eventually adopted, the curves, if extended beyond 250 cylinders, would undoubtedly approach the horizontal.

### Two-minute concrete a waste

Fig. 5 shows that, with equipment and concrete such as was used on dam No. 4, it is a waste of money to mix concrete 2 min. While other aggregates, proportions, consistencies or equipment on other jobs might favor a 2-min. mix, the Nashville test is in contrast to the failure to find in the review of published data any test supporting a 2-min. mix.

If prolonging the mixing period is under any conditions beneficial, such a benefit should exist with an inefficient mixer. In Fig. 5 mixer *A* is not so efficient as mixer *B*, notwithstanding which, with mixer *A*, no benefit is shown for the 2-min. mix. Evidently it was more important to mix dam No. 4 concrete properly than to mix it an exceptionally long time.

Manufacturers design mixers, irrespective of their sizes, to turn out a batch of 1-min. concrete approximately every 70 sec., or at the rate of 51 batches per hour. Two-minute concrete limits the output to 27 batches per hour. On many jobs distributing equipment can maintain 51 batches per hour, in which event twice as much concrete mixing plant is necessary for a 2-min. mix as for a 1-min. mix.

# Solving Vertical Highway Curves by Graph and Table

## Single multiplication determines any ordinate from tangent grade to curve

By Robert W. Abbett
*Instructor in Civil Engineering, Yale University, New Haven, Conn.*

DESIGNING ENGINEERS in state highway and municipal organizations are required to make computations for an interminable number of vertical curves. Use of the following diagram and table has been found to reduce materially the labor and time ordinarily involved in these computations.

For the parabolic vertical curve the ordinate from the tangent grade to the curve at the P.I. is ordinarily found from the formula $Y_o = \frac{LG}{800}$ in which $L$ is the length of the horizontal projection of the curve and $G$ is the algebraic difference of the percentages of the intersecting gradients. This formula is solved graphically by the diagram for the usual curve lengths.

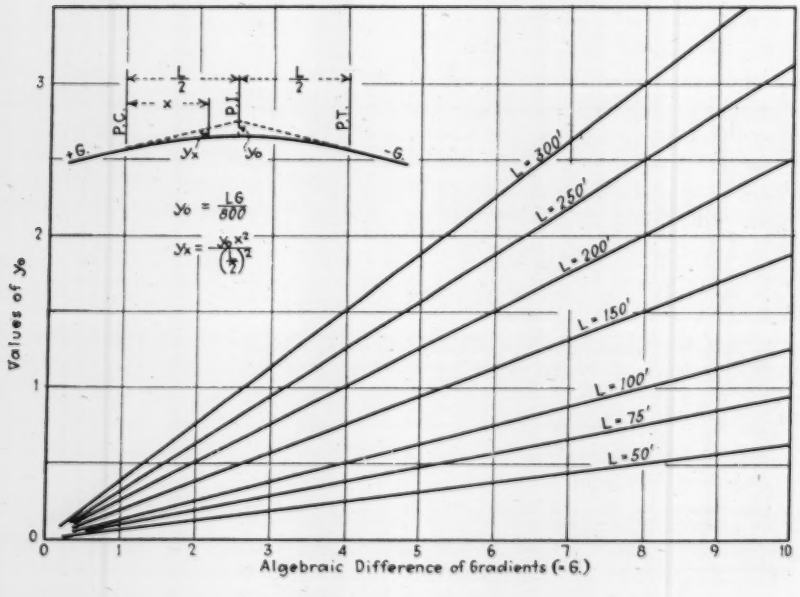
The ordinate from the tangent grade to the curve at any point between the P.C. (or P.T.) and the P.I. is $Y_x = \frac{Y_o \ X^2}{\left(\frac{L}{2}\right)^2}$. The table gives values of $\frac{X^2}{\left(\frac{L}{2}\right)^2}$ for various curve lengths; therefore $Y_x = Y_o$ multiplied by the tabular value for $X$.

The diagram may readily be extended to additional values of $L$ by direct interpolation or exterpolation, since $Y_o$ varies directly with $L$. The table also may be extended to additional values of $L$, since values of $\frac{X^2}{\left(\frac{L}{2}\right)^2}$ for similar values of $X$ are the same for all curve lengths ($X = 10$ ft. for a 100-ft. curve corresponds to $x = 20$ ft. for a 200-ft. curve.)

Values of $\frac{X^2}{\left(\frac{L}{2}\right)^2}$ for the formula $y_x = \frac{y_o X^2}{\left(\frac{L}{2}\right)^2}$ where $y_x$ is vertical ordinate at any distance from P.C. of vertical Curves

| Dist. from P.C. | L=75' | L=100' | L=150' | L=200' | L=250' | L=300' | Dist. from P.C. | L=150' | L=200' | L=250' | L=300' | Dist. from P.C. | L=250' | L=300' |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.001 | 0000 | 0000 | 0000 | 0000 | 0000 | 51 | 0462 | 0260 | 0166 | 0116 | 101 | 0653 | 0453 |
| 2 | 0003 | 0002 | 0001 | 0000 | 0000 | 0000 | 52 | 0481 | 0270 | 0173 | 0120 | 102 | 0666 | 0462 |
| 3 | 0006 | 0004 | 0002 | 0001 | 0001 | 0000 | 53 | 0499 | 0281 | 0180 | 0125 | 103 | 0679 | 0472 |
| 4 | 0012 | 0006 | 0003 | 0002 | 0001 | 0001 | 54 | 0518 | 0292 | 0187 | 0130 | 104 | 0692 | 0481 |
| 5 | 0018 | 0010 | 0004 | 0003 | 0002 | 0001 | 55 | 0538 | 0303 | 0194 | 0135 | 105 | 0706 | 0490 |
| 6 | 0026 | 0014 | 0006 | 0004 | 0002 | 0002 | 56 | 0557 | 0314 | 0201 | 0140 | 106 | 0719 | 0499 |
| 7 | 0035 | 0020 | 0009 | 0005 | 0003 | 0002 | 57 | 0578 | 0325 | 0208 | 0145 | 107 | 0733 | 0509 |
| 8 | 0045 | 0026 | 0012 | 0006 | 0004 | 0003 | 58 | 0598 | 0336 | 0215 | 0150 | 108 | 0746 | 0518 |
| 9 | 0058 | 0032 | 0014 | 0008 | 0005 | 0004 | 59 | 0619 | 0348 | 0223 | 0155 | 109 | 0760 | 0528 |
| 10 | 0071 | 0040 | 0018 | 0010 | 0006 | 0004 | 60 | 0640 | 0360 | 0230 | 0160 | 110 | 0774 | 0538 |
| 11 | 0086 | 0048 | 0022 | 0012 | 0008 | 0005 | 61 | 0662 | 0372 | 0238 | 0166 | 111 | 0789 | 0548 |
| 12 | 0102 | 0058 | 0026 | 0014 | 0009 | 0006 | 62 | 0683 | 0384 | 0246 | 0171 | 112 | 0803 | 0557 |
| 13 | 0120 | 0068 | 0030 | 0017 | 0011 | 0008 | 63 | 0706 | 0397 | 0254 | 0176 | 113 | 0817 | 0567 |
| 14 | 0140 | 0078 | 0035 | 0020 | 0013 | 0009 | 64 | 0728 | 0410 | 0262 | 0182 | 114 | 0832 | 0578 |
| 15 | 0160 | 0090 | 0040 | 0023 | 0015 | 0010 | 65 | 0751 | 0423 | 0271 | 0188 | 115 | 0846 | 0588 |
| 16 | 0182 | 0102 | 0045 | 0026 | 0017 | 0012 | 66 | 0774 | 0436 | 0279 | 0194 | 116 | 0861 | 0598 |
| 17 | 0206 | 0116 | 0052 | 0029 | 0019 | 0013 | 67 | 0798 | 0449 | 0287 | 0200 | 117 | 0876 | 0608 |
| 18 | 0230 | 0130 | 0058 | 0032 | 0021 | 0014 | 68 | 0822 | 0462 | 0296 | 0206 | 118 | 0891 | 0619 |
| 19 | 0257 | 0144 | 0064 | 0036 | 0023 | 0016 | 69 | 0846 | 0476 | 0305 | 0212 | 119 | 0906 | 0629 |
| 20 | 0284 | 0160 | 0071 | 0040 | 0026 | 0018 | 70 | 0871 | 0490 | 0314 | 0218 | 120 | 0922 | 0640 |
| 21 | 0314 | 0176 | 0078 | 0044 | 0028 | 0020 | 71 | 0896 | 0504 | 0323 | 0224 | 121 | 0937 | 0651 |
| 22 | 0344 | 0194 | 0086 | 0048 | 0031 | 0022 | 72 | 0921 | 0518 | 0332 | 0230 | 122 | 0953 | 0662 |
| 23 | 0376 | 0212 | 0094 | 0053 | 0034 | 0024 | 73 | 0947 | 0533 | 0341 | 0237 | 123 | 0968 | 0672 |
| 24 | 0410 | 0230 | 0102 | 0058 | 0037 | 0026 | 74 | 0973 | 0548 | 0351 | 0244 | 124 | 0984 | 0683 |
| 25 | 0444 | 0250 | 0111 | 0063 | 0040 | 0028 | 75 | 1.000 | 0563 | 0360 | 0250 | 125 | 1.000 | 0694 |
| 26 | 0481 | 0270 | 0120 | 0068 | 0044 | 0030 | 76 | — | 0578 | 0370 | 0257 | 126 | — | 0706 |
| 27 | 0518 | 0292 | 0130 | 0073 | 0047 | 0032 | 77 | — | 0593 | 0380 | 0264 | 127 | — | 0717 |
| 28 | 0557 | 0314 | 0140 | 0078 | 0050 | 0035 | 78 | — | 0608 | 0389 | 0270 | 128 | — | 0728 |
| 29 | 0598 | 0336 | 0150 | 0084 | 0054 | 0037 | 79 | — | 0624 | 0399 | 0277 | 129 | — | 0740 |
| 30 | 0640 | 0360 | 0160 | 0090 | 0058 | 0040 | 80 | — | 0640 | 0410 | 0284 | 130 | — | 0751 |
| 31 | 0683 | 0384 | 0171 | 0096 | 0061 | 0043 | 81 | — | 0656 | 0420 | 0292 | 131 | — | 0763 |
| 32 | 0728 | 0410 | 0182 | 0102 | 0065 | 0045 | 82 | — | 0672 | 0430 | 0299 | 132 | — | 0774 |
| 33 | 0774 | 0436 | 0194 | 0109 | 0070 | 0048 | 83 | — | 0689 | 0441 | 0306 | 133 | — | 0786 |
| 34 | 0822 | 0462 | 0206 | 0116 | 0074 | 0052 | 84 | — | 0706 | 0452 | 0314 | 134 | — | 0798 |
| 35 | 0871 | 0490 | 0218 | 0123 | 0079 | 0055 | 85 | — | 0723 | 0463 | 0321 | 135 | — | 0810 |
| 36 | 0921 | 0518 | 0230 | 0130 | 0083 | 0058 | 86 | — | 0740 | 0474 | 0329 | 136 | — | 0822 |
| 37 | 0973 | 0546 | 0244 | 0137 | 0088 | 0061 | 87 | — | 0757 | 0484 | 0336 | 137 | — | 0834 |
| 38 | — | 0578 | 0257 | 0144 | 0092 | 0064 | 88 | — | 0774 | 0495 | 0344 | 138 | — | 0846 |
| 39 | — | 0608 | 0270 | 0152 | 0097 | 0068 | 89 | — | 0792 | 0507 | 0352 | 139 | — | 0859 |
| 40 | — | 0640 | 0284 | 0160 | 0102 | 0071 | 90 | — | 0810 | 0518 | 0360 | 140 | — | 0871 |
| 41 | — | 0672 | 0299 | 0168 | 0108 | 0075 | 91 | — | 0828 | 0530 | 0368 | 141 | — | 0884 |
| 42 | — | 0706 | 0314 | 0176 | 0113 | 0078 | 92 | — | 0846 | 0541 | 0376 | 142 | — | 0896 |
| 43 | — | 0740 | 0329 | 0185 | 0118 | 0082 | 93 | — | 0865 | 0554 | 0384 | 143 | — | 0909 |
| 44 | — | 0774 | 0344 | 0194 | 0124 | 0086 | 94 | — | 0884 | 0566 | 0393 | 144 | — | 0921 |
| 45 | — | 0810 | 0360 | 0203 | 0130 | 0090 | 95 | — | 0903 | 0578 | 0401 | 145 | — | 0934 |
| 46 | — | 0846 | 0376 | 0212 | 0136 | 0094 | 96 | — | 0922 | 0590 | 0410 | 146 | — | 0947 |
| 47 | — | 0884 | 0393 | 0221 | 0141 | 0098 | 97 | — | 0941 | 0602 | 0418 | 147 | — | 0960 |
| 48 | — | 0922 | 0410 | 0230 | 0147 | 0102 | 98 | — | 0960 | 0614 | 0427 | 148 | — | 0973 |
| 49 | — | 0960 | 0427 | 0240 | 0154 | 0107 | 99 | — | 0980 | 0627 | 0436 | 149 | — | 0987 |
| 50 | — | 1.000 | 0444 | 0250 | 0160 | 0111 | 100 | — | 1.000 | 0640 | 0444 | 150 | — | 1.000 |

**Values of middle ordinates of vertical curves by algebraic difference of gradients for different curve lengths.**




## Findings of Hydro Power Costs by Commission Upheld

The right of the Federal Power Commission to determine currently the actual cost of the construction of hydro-electric developments carried out under its permit has been sustained by the U. S. Supreme Court through its dismissal of the appeal of the Clarion River Power Co. from decisions of lower courts upholding the commission's right to make such determinations.

The court said that the company has the right to appeal to the courts as to the constitutionality of the commission's findings when such findings are used for rates for other purposes.

# City Growth and Decay Revealed by Census Figures

**Records of Cleveland, Boston and St. Louis show that delimited areas reach a point of maximum population and then begin to decline—Rapid growth is confined to recently annexed areas**

By Howard W. Green

*Secretary, Cleveland Health Council, Cleveland, Ohio*

CLOSE STUDY of the Cleveland census figures, corroborated by those of Boston and St. Louis, shows that cities go through a process of growth and decay. Delimited areas increase in population until a maximum is reached, and thereafter decline. The net increase for a city as a whole is maintained by the increase that takes place within areas recently annexed. In

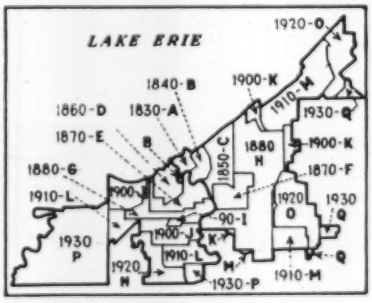



**Fig. 1—Map of Cleveland, Ohio, showing the number of annexations that have taken place and the years in which they were first included in Cleveland population figures.**

each of the three cities studied there is a constantly enlarging area that is experiencing a decline in population.

The population records of these cities have been studied in detail, and the population within each of a number of areas has been determined for each decennial year—for example, the Cleveland area as it was bounded in 1830. Such figures disclose, in this case, that the population of the area, which was 1,076 in 1830, increased to a maximum of 9,090 in 1870 and since that time has been decreasing. In 1930 it was 1,691, only slightly higher than it had been a century before. The Bureau of the Census in establishing in 1910 the small geographically constant areas called census tracts made this task simpler during recent years, and the use of the block system of enumeration in 1930 made it possible to determine these populations with a high degree of accuracy.

Between 1910 and 1920 there was a decrease in population in 25 of the census tracts, representing 13 per cent of the area of the 1910 city. The decrease in this area was 20,692 from 101,773, or 20 per cent. The remaining tracts meanwhile increased 209,332 from 458,890, or 46 per cent, yielding a net increase of 188,640, or 34 per cent, for the total area within the 1910 boundaries.

There was a decrease in population between 1920 and 1930 in 92 census tracts, representing 37 per cent of the area of the city of 1920. The decrease in these tracts was 81,612 from 441,253.

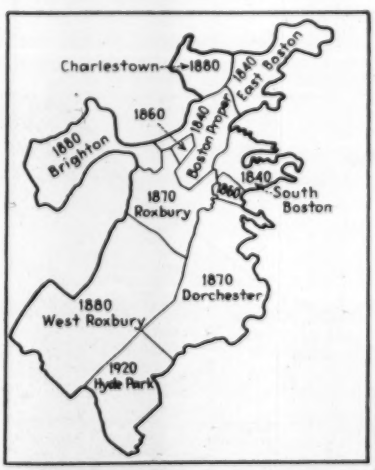



**Fig. 2—Boston, Mass., and its annexations, together with the years in which they were first included in the Boston population.**

**Fig. 3—Population growth of Cleveland and of the areas within the city boundaries as they existed in specified years.**

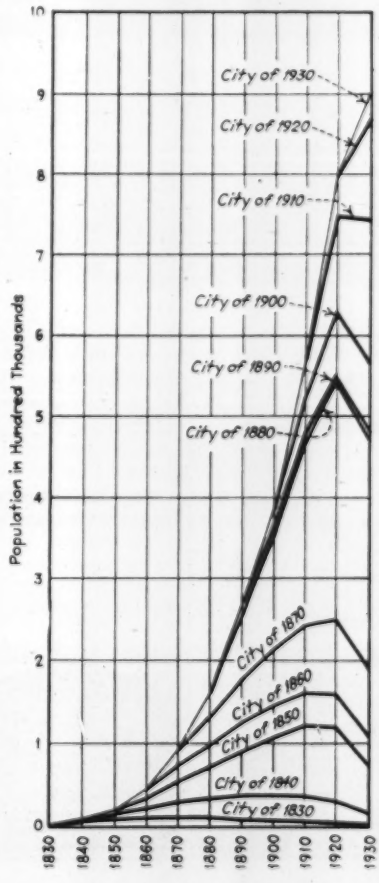



**Fig. 4—Population contributed during each decade by original city of Cleveland and the subsequent annexations. The letters refer to the areas shown in Fig 1.**

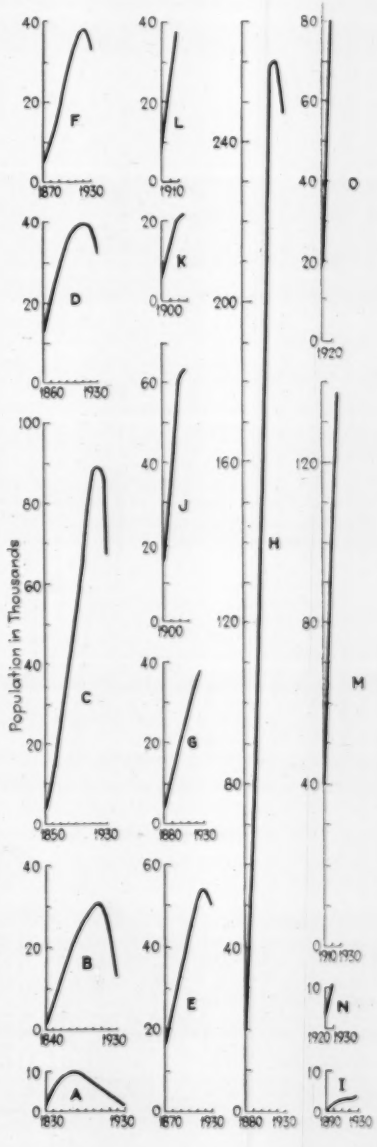


TABLE I — POPULATION OF VARIOUS AREAS AT EACH DECENNIAL YEAR
CLEVELAND, OHIO, 1830–1930

| Area | First Census After Annexation | 1830 | 1840 | 1850 | 1860 | 1870 | 1880 | 1890 | 1900 | 1910 | 1920 | 1930 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 1830 | 1,076 | 5,301 | 7,973 | 8,835 | 9,090 | 8,560 | 7,657 | 6,017 | 4,604 | 3,079 | 1,691 |
| B | 1840 | ..... | 770 | 6,250 | 12,313 | 18,989 | 24,344 | 27,603 | 30,003 | 30,943 | 25,787 | 13,752 |
| City of | 1840 | ..... | 6,071 | 14,223 | 21,148 | 28,079 | 32,404 | 35,260 | 36,020 | 35,547 | 28,856 | 15,445 |
| C | 1850 | ..... | ..... | 2,811 | 10,622 | 24,708 | 37,554 | 52,665 | 68,418 | 83,841 | 89,910 | 61,226 |
| City of | 1850 | ..... | ..... | 17,034 | 31,770 | 52,787 | 70,458 | 87,925 | 104,438 | 120,888 | 118,776 | 76,669 |
| D | 1860 | ..... | ..... | ..... | 11,647 | 20,018 | 27,188 | 35,124 | 38,357 | 39,982 | 39,468 | 32,497 |
| City of | 1860 | ..... | ..... | ..... | 43,417 | 72,805 | 97,646 | 123,049 | 144,295 | 160,870 | 158,244 | 109,166 |
| E&F | 1870 | ..... | ..... | ..... | ..... | 20,024 | 34,265 | 52,292 | 69,907 | 84,195 | 92,090 | 84,155 |
| City of | 1870 | ..... | ..... | ..... | ..... | 92,829 | 131,911 | 175,341 | 212,702 | 243,565 | 250,334 | 193,321 |
| G&H | 1880 | ..... | ..... | ..... | ..... | ..... | 28,235 | 84,782 | 143,803 | 227,411 | 295,822 | 286,219 |
| City of | 1880 | ..... | ..... | ..... | ..... | ..... | 160,146 | 260,123 | 356,505 | 470,976 | 546,156 | 479,540 |
| I | 1890 | ..... | ..... | ..... | ..... | ..... | ..... | 1,230 | 1,800 | 2,400 | 3,000 | 3,637 |
| City of | 1890 | ..... | ..... | ..... | ..... | ..... | ..... | 261,353 | 358,305 | 473,376 | 549,156 | 483,177 |
| J&K | 1900 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 23,463 | 46,640 | 80,692 | 85,611 |
| City of | 1900 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 381,768 | 520,016 | 629,848 | 568,788 |
| L&M | 1910 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 40,647 | 119,455 | 175,503 |
| City of | 1910 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 560,663 | 749,303 | 744,291 |
| N&O | 1920 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 47,538 | 119,732 |
| City of | 1920 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 796,841 | 864,023 |
| P&Q | 1930 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 36,406 |
| City of | 1930 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 900,429 |

TABLE II — POPULATION AND DENSITY OF MAXIMUM YEAR AND MOST RECENT YEAR
CLEVELAND, OHIO

| Area | First Census After Annexation | Area in Sq. Mi. | Year of Maximum Population | Maximum Population | Maximum Gross Density | 1930 Population | 1930 Density per Acre Gross | 1930 Density per Acre Net* |
|---|---|---|---|---|---|---|---|---|
| **EAST** | | | | | | | | |
| A | 1830 | .74 | 1870 | 9,090 | 19 | 1,691 | 4 | 423 |
| B | 1840 | 1.27 | 1910 | 30,943 | 38 | 13,752 | 17 | 62 |
| C | 1850 | 3.39 | 1920 | 89,910 | 41 | 61,226 | 28 | 53 |
| F | 1870 | 2.12 | 1920 | 38,140 | 27 | 33,864 | 24 | 56 |
| H | 1880 | 13.41 | 1920 | 260,995 | 30 | 247,599 | 29 | 46 |
| K | 1900 | 1.34 | 1930 | 21,907 | 26 | 21,907 | 26 | 46 |
| M | 1910 | 7.93 | 1930 | 137,722 | 27 | 137,722 | 27 | 37 |
| O | 1920 | 7.76 | 1930 | 108,442 | 22 | 108,442 | 22 | 28 |
| Q | 1930 | 1.01 | 1930 | 602 | 1 | 602 | 1 | 1 |
| **WEST** | | | | | | | | |
| D | 1860 | 2.02 | 1910 | 39,982 | 31 | 32,497 | 25 | 42 |
| E | 1870 | 2.47 | 1920 | 53,950 | 34 | 50,291 | 32 | 45 |
| G | 1880 | 2.58 | 1930 | 38,620 | 23 | 38,620 | 23 | 52 |
| I | 1890 | .15 | 1930 | 3,637 | 38 | 3,637 | 38 | 47 |
| J | 1900 | 4.68 | 1930 | 63,704 | 21 | 63,704 | 21 | 33 |
| L | 1910 | 3.87 | 1930 | 37,781 | 15 | 37,781 | 15 | 25 |
| N | 1920 | 2.91 | 1930 | 11,290 | 6 | 11,290 | 6 | 10 |
| P | 1930 | 13.26 | 1930 | 35,751 | 4 | 35,751 | 4 | 6 |

* Net area excludes industrial and railroad property, parks, cemeteries and public property.

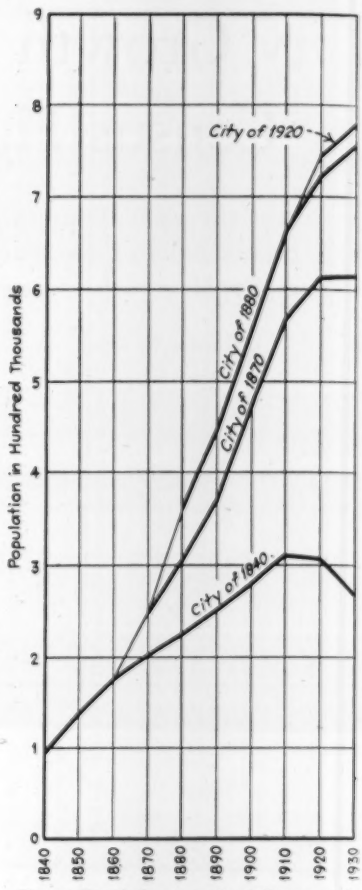



Fig. 7—Population growth of Boston and of the areas within the city boundaries as they existed in specified years.

or 18 per cent, while the remaining tracts, increased 148,794 from 355,584, or 42 per cent. The resulting net increase within the 1920 boundaries was thus 67,182, or 8 per cent.

When the annexed areas are considered individually it is found that all areas that became part of the city prior to 1872 are now declining in population. They have characteristically reached their maximum points about five decades after annexation. Population figures are given in Table I for each of these areas for each census year after its date of annexation.

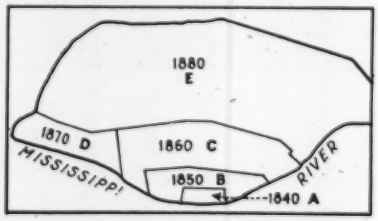



Fig. 6—St. Louis, Mo., and its various annexations.

The percentage change in population for each of the 201 census tracts of 1930 during each of the past two decades between censuses is shown graphically in Fig. 5. It is evident that the boundary of the area of declining population is rapidly moving outward. Rapid growth is confined exclusively to the peripheral area, with much of the most rapidly growing territory outside the city boundaries. The diagrams give further evidence that the core of Cleveland is becoming depopulated while the rim is being built up.

These data, however, should not be taken to mean that the older areas of

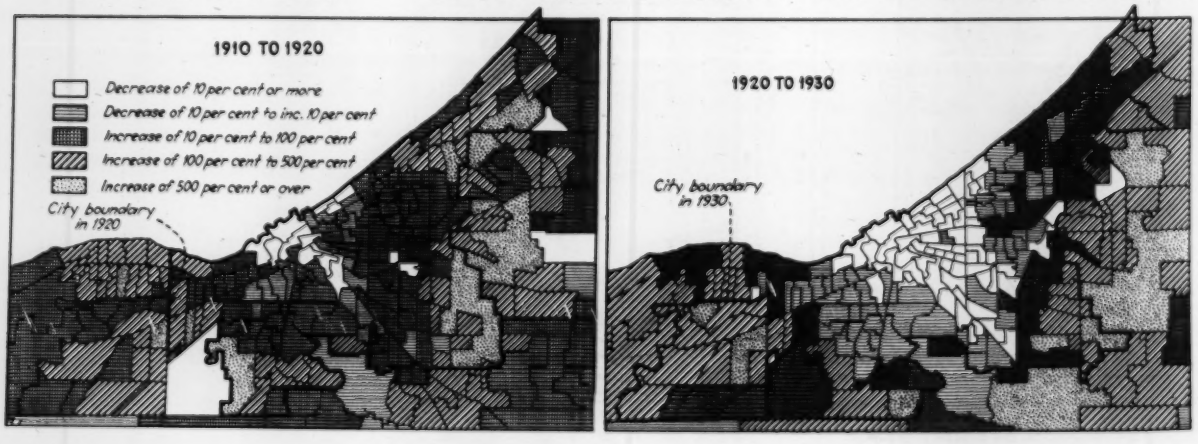

1910 TO 1920
Decrease of 10 per cent or more
Decrease of 10 per cent to inc. 10 per cent
Increase of 10 per cent to 100 per cent
Increase of 100 per cent to 500 per cent
Increase of 500 per cent or over
City boundary in 1920
1920 TO 1930
City boundary in 1930

Fig. 5—Rate of change of population of Cleveland and suburbs for the decades 1910 to 1920 and 1920 to 1930. The boundaries of the area of stationary or declining population are rapidly moving outward.

the city are sparsely populated. Because of the commercial and industrial development of these sections there is now less area available for residential use. Based upon net area—that is, area exclusive of industrial and railroad property, parks, cemeteries and public property—the greatest density of population in Cleveland is still to be found in the original 1830 area. Population densities of the city's various annexations are shown in Table II for 1930.

Similar analyses of the population history of Boston and St. Louis substantiate the Cleveland findings. In Fig. 7 Boston's population has been plotted in the same manner as Cleveland's was in Fig. 3. Boston has had only one annexation since 1880, which was Hyde Park in 1912. It appears that the small increase in population during the last decade was due to its failure to extend the city boundaries in the past to take in territory destined to increase rapidly in population.

The population growth of St. Louis, which shows exactly the same characteristics, is shown in Fig. 9. This city has annexed no territory since 1876.

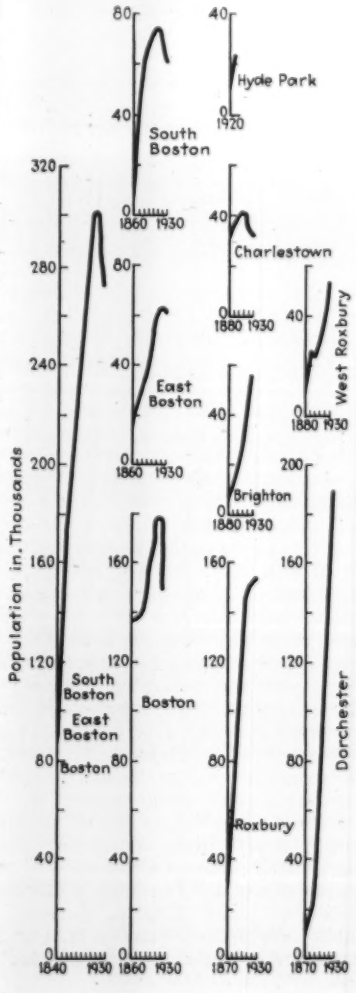



**Fig. 8—Population contributed during each decade by the original city of Boston and the subsequent annexations.**

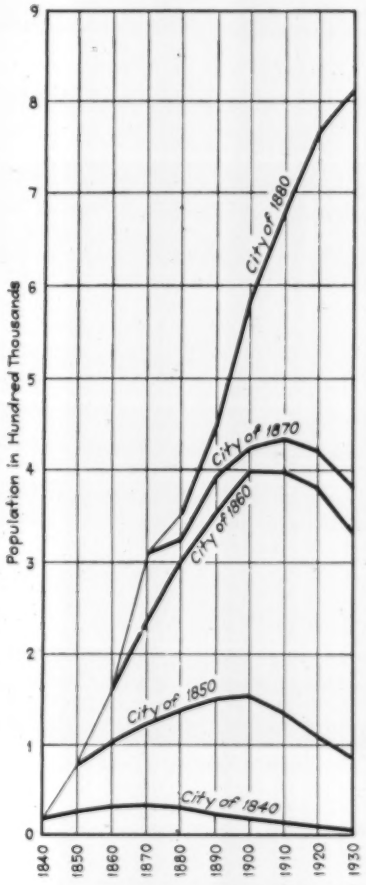


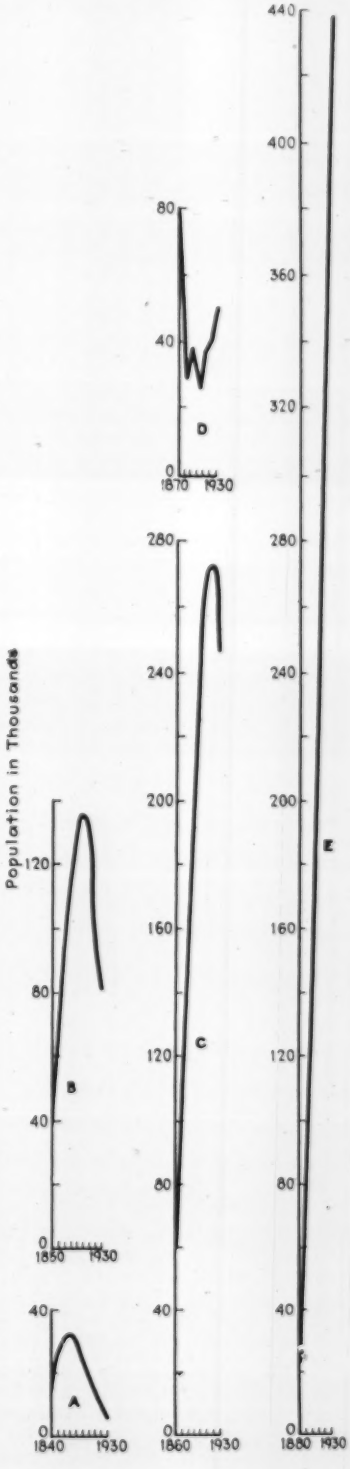

**Fig. 9—Population growth of St. Louis and of the areas within the city boundaries as they existed in specified years.**

These are the facts as disclosed by the figures of the Bureau of the Census. How does such a state of affairs come about? The process of growth and decay might be stated somewhat as follows:

The original city areas become populous and the inhabitants begin to migrate to adjacent outlying areas. This territory then becomes annexed to the central city, becomes populous in turn, and the process continues. The original areas meanwhile become less and less suitable for residences and are used to a growing extent for commercial and industrial establishments. The area once given over to fine old homes is invaded by business, some of the families move away, and their dwellings become cheap lodging houses. At this period the area is of little value for residential purposes, and business has not yet expanded sufficiently to demand it. Residential values decline, and values are only maintained by the hope that business will some day pay high prices for downtown property. In other words, the area is blighted. Finally the dwellings are razed, and their sites are used for new hotels, office buildings and commercial undertakings of all sorts. The displaced population moves into newer and more spacious areas, thereby hastening the necessity for further annexations.

This entire process is dependent upon convenience of transportation between the central city and the suburban areas.

**Fig. 10—Population contributed during each decade by the original St. Louis and the subsequent annexations.**



It was stimulated in the past by the introduction of the electric street-car and has been tremendously accelerated more recently by the development of the automobile. But the outward movement of the population adds greatly to the total cost of transportation and other public services by creating large thinly populated areas through which expensive service facilities must pass to reach the people living in the outskirts.

Population immediately adjacent to the central cities in all cases shows ever greater rates of increase. Between 1910 and 1920 the population of the city of Cleveland of 1930 increased 41 per cent, and between 1920 and 1930 it increased 12 per cent; while between 1910 and 1920 Cuyahoga County, outside Cleveland of 1930, increased 115 per cent, and between 1920 and 1930, 119 per cent. This constantly increasing rate of growth outside of the central city has resulted in the formation of satellite cities, eleven of which now surround Cleveland and confine it within rather restricted bounds. The condition is similar in Boston, and in St. Louis it effectually prevents further annexations.

# Tank Piers Carried 50 Ft. to Rock Through Old Coal Mine

**Footings built up to roof of mine support tall concrete piers reinforced only in the upper 25 ft. where soft material was encountered**

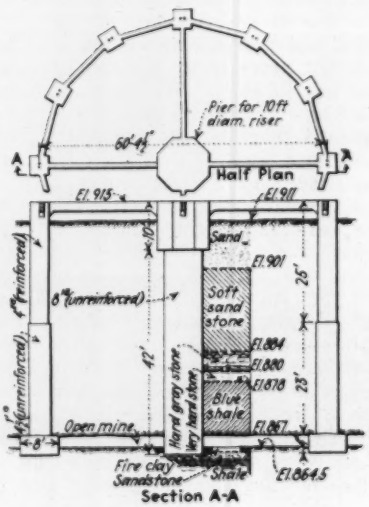
IN BUILDING an 800,000-gal. elevated steel tank, part of a water-supply improvement for the city of Zanesville, Ohio, unusual foundation procedure was made necessary because a partly worked coal mine underlay the tank site. Inasmuch as the coal was not of very high grade, it had never been commercially mined, and residents dug it mainly for their own use. Therefore, no maps or records were available to show how thick the vein was or how much it had been worked. Careful foundation exploration consequently was necessary.

A 2-in. test hole first was bored. Coal was found at a depth of 44 ft., at which elevation the drill wedged. With more pressure applied the drill dropped about 2 ft., went through about 1 ft. of soft shale, then through 1 ft. of hard clay, finally encountering rock.

Since there seemed to be evidence from this test boring that coal had been removed, an 8-ft. exploratory shaft was sunk to mine level. This shaft was located at the site of the central 10-ft. riser pipe so that it could serve also as excavation for part of the finished tank foundation. Material encountered checked closely with that shown in the test boring. Under the upper 10 ft. of sand all material above the mine was discovered to be shale and stone. The soft material encountered under the mine by the drill proved to be droppings from the mine roof. In the mine it was found that about 85 per cent of the coal had been removed, the remaining 15 per cent being contained in the coal pillars. Although there were no surface indications of mine settlement, the overburden weight had tended to crush the pillars, making them rotten. Several days after the shaft had been sunk the shale in the mine roof disintegrated, almost filling the opening.

Three foundation plans were considered. The first plan contemplated the building of short concrete piers between rock under the mine floor and mine roof, located under the tank columns, and the sinking of tank-column footings either below frost level or to rock. However, when calculations of mine piers large enough to support both tank and overburden load were made, it was estimated that the piers would have to form almost a continuous ring. The amount of concrete required and the difficulty of working in the mine made this plan impracticable.

**Elevated tank built over abandoned coal mine requires foundation piers nearly 50 ft. deep.**




The second plan contemplated boring a 2-in. hole directly under each column down to the mine, through which a grout footing could be built up on the mine floor. It was believed that debris on the mine floor would tend to dam the grout if it were not too thin. After this concrete had set, all the cracks and crevices above the mine floor would be grouted. This plan was discarded because of the comparatively high cost of grout, and because the method depended for its effectiveness on the ultimate stability of the entire overburden.

In building the exploratory shaft the rock encountered was soft enough so that blasting was unnecessary and hard enough so that lagging was not required. Although the upper 10 ft. of sand obviously had to be held, shaft excavation would not be nearly so expensive as had been anticipated.

The plan followed comprised sinking neat-size shafts under each column, thus eliminating formwork except at the upper 10 ft. Piers were insulated with ½-in. lumber, where they passed through rock, so that when they shortened under loading there would be no tendency toward pulling overburden along with them and thus increasing the load on the column footings. Columns were designed with a cross-sectional area of such size (16 sq.ft.) that all the load could be carried by unreinforced concrete. The lower portion was made round to give a workman maximum working space, but where formwork was required in the upper portion the section was made 4 ft. square.

Reinforced-concrete struts were placed between the tops of the column piers, extending from pier to pier, and four concrete struts tied the pier ring into the center pier. Reinforcing steel was used in the columns from their tops well into rock, to give lateral stiffness only.

Footings were designed to carry the column load plus the weight of the overburden that had been carried by the coal pillars, which were removed while excavating for the footings. Footings were built up to the roof of the mine and down through 1 ft. of clay and keyed 6 in. into the underlying rock. Being 4 ft. thick, they required no reinforcement.

The center pier was carried from the rock below the mine floor as an 8-ft. square shaft of lean concrete to within 10 ft. of the foundation top, when it was spread to an 11-ft. octagon, filling the exploratory shaft.

The work was done by the Dunzweiler Construction Co., of Zanesville. The foundation plans were prepared by the Pittsburgh-Des Moines Steel Co., Pittsburgh, R. H. Beck, contracting engineer, which company also furnished and erected the tank. The work was supervised by James Kinney, director of public service, and Charles H. Duvall, waterworks engineer, city of Zanesville.

# St. Louis Light Standards Too Small at Top and Spall Off

SOME 5,000 concrete light standards in St. Louis in 1920 and '21 were designed, by contract, too thin at the top of the shaft to permit getting sufficient concrete around the reinforcing to prevent entrance of moisture, formation of rust and subsequent spalling, as is shown in the accompanying cut. These standards had a mounting height of 14½ ft. and were square with chamfered corners. They were but 4 in. in diameter at the top, and were battered out to 8½ in. in a length of 12 ft. At this point the base curved out to a diameter of 18 in. Reinforcement consisted of four ⅝-in. round rods and a central

**Light standard in St. Louis damaged by spalling, caused by moisture penetrating to the reinforcement.**

1¼ in. iron pipe, all running the whole length of the pole. In 1923 city forces made 3,000 standards according to the same pattern, but they inclosed a 2-in. galvanized-iron pipe and were reinforced with eight ⅝-in. round rods, four of which stopped half-way up.

The poles of the first lot were made with torpedo gravel from the Meramec River, those of the second lot with crushed granite. All were cast horizontally in wooden molds. The shaft was so thin at the top and was so filled with the bars and the pipe that there was little room for tamping. Apparently a fairly dry mixture was used, and the quality of the concrete is not considered particularly high. In consequence, moisture has penetrated to the bars, causing them to rust. In many cases cracks formed and large fragments spalled off. On the other hand the concrete inside the core is in excellent condition. In the lower part of the standards, where the bars were not so close to the surface, the concrete is still in good condition. Practically all cracking and spalling is found to have taken place in the upper 36 in. of the shaft.

No estimate is available of the exact number of standards that are affected, but John C. Pritchard, director of public utilities, believes it may run to 2,000. As the standards are not in a dangerous condition and as the reinforcing rods and pipe are amply able to support the lantern, no attempt is being made at present to replace them.

Under the bond issue of 1923 a new specification was written calling for manufacture by the centrifugal process. The design was changed slightly, increasing the top diameter to 5½ in. and omitting the pipe, as centrifugally cast poles have a central hole in them. Reinforcing was six ⅜-in. rods, and the aggregate was red granite. Of several thousand in place more than seven years not a single standard has cracked in the manner of the original standards. There are some 30,000 centrifugal standards, ranging in height from 14½ to 24½ ft., and Mr. Pritchard states that they are of such dense concrete as to preclude the penetration of moisture with the attendant formation of rust.

# Sheeting Interlocked on Barge for Cofferdam Wall

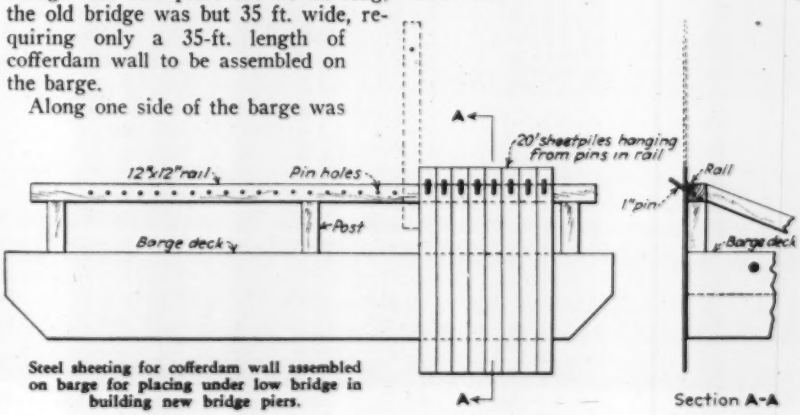
PIERS for a new concrete multiple-arch highway bridge across the Mohawk River between Cohoes and Waterford, N. Y., were built under an old existing steel-truss structure while it was still in service. Single-wall cofferdams of 20-ft. steel sheetpiles were required in constructing the new piers. The rock line averaged 17 ft. below water surface. As the clearance between the river and floor of the old bridge was but 16 ft., some means of interlocking the sheeting before setting in place was necessary. For the cofferdam section directly underneath the old bridge it was impossible to use the ordinary procedure of lifting the sheets one by one high enough to drop them into the interlocks of sheets already in place.

This difficulty was overcome by hanging a row of interlocked sheeting from the side of a barge, assembling the sheeting out in the open. The barge was then maneuvered alongside the waling frame, already set, and interlocked sheets were dropped one by one into place. Although the new piers are 70 ft. long, the old bridge was but 35 ft. wide, requiring only a 35-ft. length of cofferdam wall to be assembled on the barge.

Along one side of the barge was placed a 12x12-in. timber rail 5 ft. above the deck. Into this timber holes were drilled from the outboard side to take 1-in. pins, the holes being spaced to correspond with the center line of each sheetpile after assembling. With the barge clear of the old bridge, the steel sheets, handled by a floating crane, were hung one by one from the timber, each pile being supported by a 1-in. pin through its lifting hole. As the sheets were assembled, extra piles were laid on the opposite side of the barge to act as counterweights.

With a full row of sheeting hanging from the barge, the scow was moved to place under the bridge. Equipped with a short mast and using a flat boom, the floating crane was able to reach the sheets and lift them, one by one, just enough for the pin to be pulled, dropping the sheets into place.

The new bridge is being built for the New York Department of Public Works by Bates & Rogers Construction Co., New York. Wm. Mattox, carpenter foreman, originated the method here described.




**Steel sheeting for cofferdam wall assembled on barge for placing under low bridge in building new bridge piers.**

# Aluminum Booms and Buckets on Mississippi Levees

**Levee-building practice on the river in 1931-1932 has swung notably to the use of aluminum-alloy booms and buckets for draglines, with a gain in reach and output**

By Douglas B. Hobbs
*Aluminum Company of America, Pittsburgh, Pa.*

THE USE of strong aluminum-alloy structural shapes and plate for the booms of dragline excavators represents the first major development in this type of equipment since the installation of diesel engines. From the standpoint of number the light-alloy boom is still in its infancy, yet the 28 that are now in operation have seen sufficient service to point to the durability and economy of aluminum for this purpose. The aluminum boom, with its longer reach and higher monthly output, is stripping coal in Pennsylvania, working on highway and irrigation projects in the West and building levees along the Mississippi River.

Fifteen aluminum booms have handled more than 6,000,000 cu.yd. of earth on the Mississippi River levee system between September, 1931, and September, 1932. Part of this time the booms were idle as a result of weather conditions, but in their actual operating time they have shown definite advantages over other existing types of booms.

In an efficient dragline the capacity, reach, speed and mobility are balanced. Monthly output is the product of these factors, and any change that increases one or more at the expense of the others may result in decreased earning power. On the other hand, if certain factors can be improved without any detrimental effect on the remaining ones, the efficiency of the excavator will naturally be somewhat higher. Just such a condition exists in the use of the strong aluminum alloys in the construction of dragline booms. The weight saved is of sufficient magnitude to make possible a substantial increase in capacity or reach without affecting the speed and mobility of the excavator.

## Comparison with steel

Experience has shown that aluminum booms can be constructed of the same length as steel booms at a saving of 40 to 50 per cent in weight without sacrificing the strength and rigidity of the heavier boom. In general, however, this saving in weight is utilized by increasing the length of the boom and the capacity of the bucket. In the average dragline the strength-weight ratio of the strong aluminum alloys will permit an increase of 15 to 20 per cent in the length of the boom or an increase of 20 to 25 per cent in the capacity of the bucket.

The comparison of a 175-ft. composite aluminum-steel boom with a 150-ft. all-steel boom will definitely show the benefits that an operator can realize through the aluminization of his equipment. The figures are based on actual service records, and all yardages are computed on a typical levee section.

*Weight Saving*—The elimination of dead weight is of the greatest value at the upper end of the boom. The application of aluminum, therefore, should extend from the peak toward the base until the desired weight reduction and stability have been attained. In some cases steel members can be used at the lower end of the boom, where excessive weight does not have as great an effect on the stability or swing speed of the machine, and it will be found that the ratio of steel to aluminum depends in a large measure on obtaining the desired performance at the lowest initial cost. In the booms under consideration the weight of the 150-ft. all-steel boom and the weight of the 175-ft. composite aluminum-steel boom in terms of aluminum and steel are given in Table I.

**Fig. 1—Comparison of 150-ft. all-steel boom with 175-ft. composite aluminum-steel boom on basis of operating range and overturning moment.**

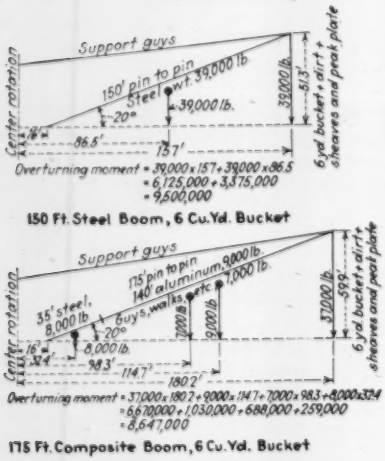
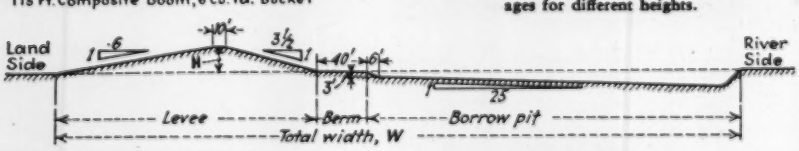

Support guys
150' pin to pin
Steel wt. 39,000 lb.
39,000 lb.
20°
86.5'
157'
Center rotation
Overturning moment = 39,000 x 157 + 39,000 x 86.5
= 6,125,000 + 3,375,000
= 9,500,000
6 yd. bucket + dirt + sheaves and peak plate
150 Ft. Steel Boom, 6 Cu. Yd. Bucket
Support guys
175' pin to pin
140' aluminum, 9,000 lb.
35' steel, 8,000 lb.
Guys, walks, etc. 7,000 lb.
20°
8,000 lb.
98.3'
114.7'
180.2'
Center rotation
Overturning moment = 37,000 x 180.2 + 9000 x 114.7 + 7000 x 98.3 + 8000 x 32.4
= 6670000 + 1,030,000 + 688,000 + 259,000
= 8,647,000
6 yd. bucket + dirt + sheaves and peak plate
175 Ft. Composite Boom, 6 Cu. Yd. Bucket

**Fig. 2—Typical cross-section of Vicksburg type levee, showing dimensions and yardages for different heights.**




| Levee Height, H | Levee Base | Pit Width | Total Width, W | Net Volume Yardage per Sta. |
|---|---|---|---|---|
| 10 Ft. | 100 Ft. | 176 Ft. | 271 Ft. | 2,130 cu.yd. |
| 15 " | 152.5 " | 205.5 " | 398 " | 4,610 " " |
| 20 " | 200 " | 285 " | 525 " | 7,780 " " |
| 25 " | 247.5 " | 366.5 " | 654 " | 11,900 " " |
| 30 " | 295 " | 448 " | 783 " | 16,920 " " |

**TABLE I—WEIGHT OF COMPOSITE 175-FT ALUMINUM-STEEL BOOM COMPARED WITH 150-FT. ALL-STEEL BOOM**

| | Lb. |
|---|---|
| **Composite Boom, 175 Ft.** | |
| Aluminum: | |
| Peak plates | 1,000 |
| Main-boom structure, except lower 35 ft. | 9,000 |
| | 10,000 |
| Steel: | |
| Peak sheaves, etc. | 4,000 |
| Lower 35 ft. of main-boom structure | 8,000 |
| Guys, walks, etc. | 7,000 |
| | 19,000 |
| Total weight, fully rigged | 29,000 |
| **All-Steel Boom, 150 Ft.** | |
| Peak sheaves, plate, etc. | 7,000 |
| Main-boom structure | 32,000 |
| Guys, walks, etc. | 7,000 |
| Total weight, fully rigged | 46,000 |
| Weight saved by aluminum | 17,000 |
| Per cent of weight saved | 37.0 |

*Stability*—The increase in the length of the boom from 150 to 175 ft. naturally brings up the question of its effect on the balance of the revolving section of the machine. If the revolving section of the excavator is not properly balanced, excessive strains will be thrown on the roller train, and in time it will fail; again, if the unbalanced condition is too great, the machine itself may tip over.

The balance or overturning moment for both the 150-ft. all-steel boom and the 175-ft. composite aluminum-steel boom is shown in Fig. 1. The overturning moment for the 175-ft. boom is 853,000 ft.-lb., or 9 per cent less than that of the 150-ft. boom. As a result, the counterweights can be reduced approximately 25,000 lb., and the total weight of the rotating parts is reduced 42,000 lb., since the boom itself is 17,000 lb. lighter than the all-steel boom.

*Swing Speed*—The swing cycle is divided into three parts: (1) acceleration, (2) uniform speed, and (3) deceleration. On a 180-deg. swing, periods one and three will just about

equal period two. The speed of acceleration and deceleration varies directly with the power available and with the swing inertia of the rotating parts. With loaded bucket, the swing inertia of the 175-ft. composite aluminum-steel boom is 8.6 per cent greater than that of the 150-ft. all-steel boom; with empty bucket, it is 4.1 per cent less. On the average machine the small net increase in inertia per cycle is not great enough to affect the results, and handling is necessary, the advantages of which are shown in Table II. In this table the operations on different height levees for both the 175-ft. composite aluminum-steel boom and the 150-ft. all-steel boom are carefully analyzed and compared.

From Table II it is evident that the boom with the longer reach has two important effects on levee construction. The increase of 25 ft. in the boom length saves the operator from 1 to 2.5c.

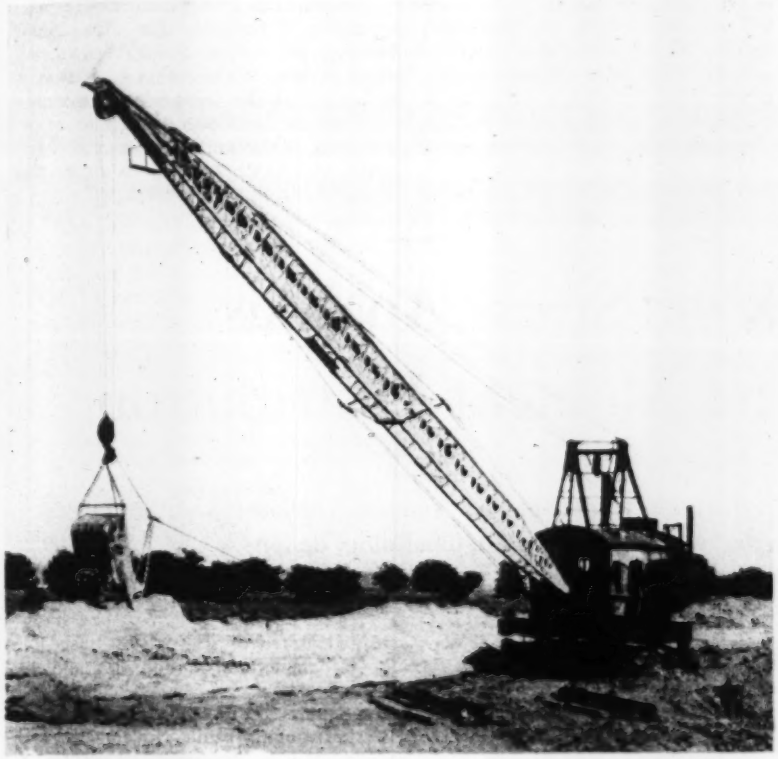


Fig. 3—175-ft. composite aluminum-steel boom with 7-cu.yd. steel bucket, operated by Arundel Corp., New Roads, La.

on both booms the speed of operation is actually the same.

*Performance* — Assuming that the dragline excavators work with the booms at an angle of 20 deg. with the horizontal, the 25-ft. increase in length, resulting from the aluminization of the boom, gives the operator a 44.4-ft. increase in working diameter and a 6.6-ft. increase in dumping height. This makes it possible to reach more earth without the necessity for rehandling and to use a higher stockpile when reper net cubic yard and increases the speed of construction from 10 to 30 per cent. The benefit of the direct saving in operating cost is obvious, and the saving in time is frequently of even greater importance, since completion dates are an essential factor in all levee-construction contracts and the operator who can guarantee the earliest date of completion has a definite advantage over the other operators bidding on the job. The increased speed of construction also results in a material saving on interest, overhead and labor charges.

Based on the figures given in Table II, the use of aluminum in boom construction makes it possible for an operator working on a 1,000,000-cu.yd. contract to save from $10,300 to $25,300 in earth-handling charges and from one to three months in a normal working year of ten months.

Fig. 4—150-ft. composite aluminum-steel boom with 8-cu.yd. steel bucket, operated by McWilliams Dredging Co., Transylvania, La.

The cost of aluminum structural shapes and plate is greater than the cost of steel structural shapes and plate. The aluminum boom, therefore, repre-

TABLE III — WEIGHT OF 2-CU.YD. STEEL BUCKETS AND 2-CU.YD. COMPOSITE ALUMINUM-STEEL BUCKETS
(All Weights in Pounds)

| | | Lb. |
|---|---|---|
| Heavy Duty | | |
| Weight of steel bucket | | 5,650 |
| Weight of composite aluminum-steel bucket | | |
| Aluminum applications | 1,600 | |
| Steel teeth, chains, etc. | 960 | |
| | | 2,560 |
| Weight saved | | 3,090 |
| Per cent of weight saved | | 54.7 |
| Medium Duty | | |
| Weight of steel bucket | | 5,000 |
| Weight of composite aluminum-steel bucket | | |
| Aluminum applications | 1,250 | |
| Steel teeth, chains, lip, etc. | 1,300 | |
| | | 2,550 |
| Weight saved | | 2,450 |
| Per cent of eight saved | | 49.0 |

TABLE II — COMPARATIVE PERFORMANCE OF 150-FT. ALL-STEEL BOOM AND 175-FT. COMPOSITE ALUMINUM-STEEL BOOM IN CONTRUCTION OF VICKSBURG TYPE LEVEE[1]

| Levee Height, Ft. | Net Cu. Yd. in Levee Per Station | 150-Ft. All-Steel Boom | | | 175-Ft. Composite Aluminum-Steel Boom | | | Advantages of Longer Boom | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Cu. Yd. Handled Per Station | Cu. Yd. Rehandled Per Station | Maximum Stations Per Month[2] | Cu. Yd. Handled Per Station | Cu. Yd. Rehandled Per Station | Maximum Stations Per Month[2] | Increase in Construction Speed, Per Cent | Increase in Monthly Income[2,3] | Saving Per Net Cu. Yd.[4] |
| 10 | 2,130 | 2,660 | 0 | 56.40 | 2,660 | 0 | 56.40 | 0 | 0 | 0 |
| 15 | 4,510 | 7,260 | 1,610 | 20.65 | 5,650 | 0 | 26.60 | 28.8 | $4,020 | 1.78c |
| 20 | 7,780 | 17,120 | 7,390 | 8.76 | 15,520 | 5,790 | 9.65 | 10.2 | 1,040 | 1.03c |
| 25 | 11,900 | 30,915 | 16,025 | 4.85 | 27,510 | 12,620 | 5.45 | 12.4 | 1,080 | 1.43c |
| 30 | 16,920 | 56,640 | 35,460 | 2.65 | 48,060 | 26,880 | 3.12 | 17.7 | 1,190 | 2.53c |

[1] Figures based on Vicksburg type levee shown in Fig. 2. Swell, 25%; waste, 10%.
[2] Based on ability of machine to handle 150,000 cu.yd. per month.
[3] Based on contract price of 15c. per cu.yd. of net levee section.
[4] Based on handling charge of 5c. per cu.yd.

TABLE IV — WEIGHT OF COMPLETELY LOADED 1½-CU.YD. STEEL BUCKET AND 2-CU.YD. COMPOSITE ALUMINUM-STEEL BUCKET
(All Weights in Pounds)

| | 2-Cu. Yd. Heavy-Duty Composite Aluminum-Steel Bucket | 1½-Cu. Yd. Heavy-Duty Steel Bucket | 2-Cu. Yd. Medium-Duty Composite Aluminum-Steel Bucket | 1½-Cu. Yd. Medium-Duty Steel Bucket |
|---|---|---|---|---|
| Weight of bucket | 2,560 | 4,540 | 2,550 | 4,000 |
| Weight of dirt | 6,000 | 4,500 | 6,000 | 4,500 |
| Total load | 8,560 | 9,040 | 8,550 | 8,550 |
| Increased payload | 1,500 | ..... | 1,500 | ..... |

sents a higher initial investment than the steel boom. Since the cost of fabricating steel and aluminum is about the same, the additional initial cost will be only that of the material itself. There may also be an additional charge for design and installation if the aluminum boom is to replace a steel boom on a used machine. This charge, however, depends entirely upon local conditions and will differ in each individual case. Because of this it would be difficult to take the design and installation charge into account in any general cost comparison and, of necessity, such a comparison must be confined to the difference cited above. With aluminum structural shapes and plate selling at approximately 40c. per pound and steel structural shapes and plate at about 2c. per pound, the composite aluminum-steel boom in Table I represents a greater initial investment than the all-steel boom in the same table. Obviously, this additional material cost for aluminum, together with any charges that may be made for design and installation, can be written off in but a few months, and after that time the composite aluminum-steel boom can be considered a distinct asset to the operator.

Fig. 5—2-cu.yd. composite aluminum-steel bucket, operated by Boone and Webster, New Madrid, Mo.

### Aluminum buckets

The use of aluminum in dragline excavators has extended to include the bucket. Dead weight is not essential for fast digging except in rock or very hard ground, and the digging ability of the bucket depends instead upon the relative location of the drag hitches and cutting edge. For economical operation, therefore, the ratio of dead weight to payload must be low. For a 2-cu.yd. steel bucket this ratio will range from 0.83 for the medium-duty type to 0.94 for the heavy-duty type. Composite aluminum-steel buckets have been built by different manufacturers to correspond in strength and ruggedness to both types of steel buckets. Although there is more metal in the heavy-duty composite bucket, the applications for aluminum have been carried further, and in both the heavy-duty and medium-duty composite aluminum-steel buckets, the ratio of dead weight to payload is approximately 0.43.

The advantage of weight saving in bucket construction may be illustrated in two ways: (1) by comparing the weights of 2-cu.yd. all-steel buckets with the weights of 2-cu.yd. composite aluminum-steel buckets, and (2) by comparing the weights of fully loaded 2-cu.yd. composite aluminum-steel buckets with the weights of fully loaded 1½-cu.yd. all-steel buckets. This is done in Tables III and IV.

As in the case of dragline booms, the aluminized dragline bucket has been in operation for a sufficient length of time to demonstrate its practicability and durability. Buckets that have now handled more than 200,000 cu.yd. of earth in levee construction conclusively indicate that the composite aluminum-steel bucket is strong enough to resist battering by stumps, rocks and hard earth and tough enough to resist the abrasive action of the earth.

# Wind-Stress Analysis and Moment Distribution

## Cross method of distributing fixed-end moments in analyzing indeterminate frames applied to the wind problem in tall-building design

By Robins Fleming
*American Bridge Co., New York, N. Y.*

AN OUTSTANDING paper of the past decade in structural theory is "Analysis of Continuous Frames by Distributing Fixed-End Moments," by Prof. Hardy Cross of the University of Illinois, published in the *Proceedings*, Am.Soc.C.E., May, 1930. The applications of the method of moment distribution are many and varied. Professor Cross lists seventeen in his paper, and his list is by no means exhaustive. His paper is limited to structures in which the joints are not displaced but merely rotate under loads. However, some of the 38 contributors who took part in the discussion that followed adjusted the method to the problems of wind design for tall buildings, and this article relates largely to that phase of the subject. An engineer wishing to obtain a thorough knowledge of the moment-distribution method may read the original paper and the discussions that are now printed together as part of *Transactions*, Am.Soc.C.E., Vol. 96 (1932), pp. 1-156.

The original paper is concise and in places not easily understood. Parts of it need further elucidation and numerical examples. Professor Mylrea, believing that the method possesses great merit and yet may be overlooked by the very men it was intended to reach—the practicing designers—has written an article entitled, "Structural Analysis Based on the Moment Distribution Method of Cross," which was published in the *Proceedings*, Engineers' Society of Western Pennsylvania, November, 1931. In the new book written by Professor Cross and Professor N. D. Morgan, "Continuous Frames of Reinforced Concrete," (John Wiley & Sons) a clear exposition of the subject is given in chapter 4.

### Sign convention

In studying the subject, one point perhaps above all others, should be emphasized. The convention of signs that is adopted for bending moments should be thoroughly understood and followed throughout. "One of the most prolific sources of error in analyses is the signs. Some system for them which is as nearly as possible fool-proof is desirable" (Cross and Morgan). Professor Cross in his paper writes: "For girders the usual convention is used, positive moment being such as sags the beam. For vertical members the same convention is applicable as for girders if the sheet is turned to read from the right, as vertical members on a drawing are usually read." Many of the contributors to the discussion prefer the convention of rotation—"Positive moment at the end of any member tends to rotate the adjacent

joint clockwise" (Professor Grinter). However, "The important factor is that the method is just as workable regardless of what sign convention is dictated by personal preference" (Black).

To what extent can the method be applied to the determination of wind stresses in a high building? Sidesway at once enters the problem. For vertical loading on a rigid-frame sidesway is seldom an important factor in design. In a building under wind loading, however, the tendency of the joints to move must be taken into account. "If a frame is analyzed on the assumption that the joints do not move and movement of the joints will actually occur, it will be found that the sum of the shears in the columns is not equal to the known shear" (Cross).

### Application to wind design

The matter of sidesway interested several contributors to the discussion. Professor Morris writes: "The method may be extended to lateral forces on a tall building with as much ease and accuracy as for vertical loads in the following steps:

1—Calculate the moments in the columns due to the lateral forces, considering the joints fixed against rotation but free to deflect laterally. The sum of the moments at the top and bottom of all the columns of a story is equal to the shear in the story, multiplied by the story height; and, as the deflections of the columns in a story due to the lateral forces are equal, the column moments and shears are proportional to the $I/L^2$ values of the columns. (When all the columns of a story are of equal height, the values of $I$, or $I/L$ may be used in proportioning the moments.)

2—Distribute the moments at the joints, considering them free to rotate, but not changing their location. This is the same process as for vertical loads.

3—Carry over the distributed moments, using a carry-over factor of $+\frac{1}{2}$ as is done for vertical loads.

4—Balance the column moments in each story by making their sum equal the shear in the story times the story height. This assumes the joints to be fixed against rotation but free to deflect laterally as in the first step. This completes a cycle, and the designer is now ready to repeat steps 2, 3 and 4 as many times as the desired accuracy may require."

Professors Large and Morris are joint authors of "The Moment Distribution Method of Structural Analysis Extended to Lateral Loads and Members of Variable Section," published as Bulletin No. 66 of the Ohio State University Engineering Experiment Station, 1931.

Professor Cross, in his closure of the discussion and more at length in the book "Continuous Frames of Reinforced Concrete," previously mentioned, gives a variation of the Morris method. "The joints are not assumed to be fixed-ended, but it is assumed that all joints not fixed have the same rotation, the moments in the girders being proportional to their $K$ $(I/L)$ values and the moments in the columns, due partly to rotation of the joints and partly to displacement of the floors, being those determined by the shears. If the ratio of girder moments to $K$ values is chosen with discretion, all the joints may often be nearly balanced before any moments are distributed. In the columns in the first story an adjustment must be made for the fixation at the base."

Detailed numerical computations are given by both Morris and Cross for the lower five stories of the twenty-story bent solved by Wilson and Maney in their "Wind Stresses in the Steel Frames of Office Buildings" (Bulletin No. 80, Engineering Experiment Station, University of Illinois, 1915), who used the slope deflection method. The work of computation is less by the Cross method, and the agreement for girder moments with those obtained by the slope deflection is more satisfactory. At the same time the Morris method provides the present writer with a clearer conception of what is meant by each step in the distribution of moments.

Of course a preliminary design is required before proceeding with the calculation of wind stresses. A design based on the vertical loading is usually sufficient, though for high and narrow buildings sections should be increased to provide for wind stresses. These modifications can hardly be made correctly except by an experienced designer.

The moment-distribution method differs from the slope-deflection method in that it is workable. For high buildings it is tedious, more and more so as the number of stories increase. With increase in height, the $I/L$ ratio of column to connecting beam increases. In the transverse bent of very tall buildings a comparatively light floor beam may be attached to a heavy column. "This relation necessitates a large number of cycles, which will prove very tedious to carry out the extent to which accuracy will demand," as H. V. Spurr said in the discussion.

To questions that may be asked regarding the value of the method, the answer is unhesitatingly given that it has a decided practical value. Of the so-called "exact" methods of determining wind stresses in many-storied buildings it is the only one feasible of application. Perhaps its greatest practical value is in the investigation of designs made by the "approximate" methods so generally used. If found advisable, the design can easily be revised.

[Editor's Note—Mr. Fleming's discussion was written before the report of the windbracing committee of the Am.Soc.C.E. was available. In that report, presented at the recent annual meeting of the Society, the committee stated that, "The Cross method of analysis is satisfactory for shallow bracing systems in buildings of moderate height in which the frame has been previously proportioned so as to maintain the floors substantially plane. It may, however, become unwieldy for tall structures, particularly if the design has not been prepared with a view to holding the joints at any floor of a bent in a straight line. Even in cases where the design has been so made as to render it unnecessary to compute the actual vertical translation of joints, it is desirable to isolate stories (by hypothetical hinges) and apply the Cross method to them individually, adding to the direct stresses in the columns the stresses in the columns immediately above."]

The moment-distribution method will not solve many of the problems of windbracing. Cross writes, in quoting the moments of the twenty-story bent, "Too many conclusions should not be drawn from this case, however: the building is too regular to be taken as typical of those variations of framing arrangement which present, in modern design, the real problems of wind stress."

The "variations of framing arrangement" are many. Assembly rooms in office buildings and ballrooms in hotels require columns to be broken in continuity. Banking rooms often have high ceilings and no interior columns. A common case of irregularity of column spacing is found in tall apartment houses. In one nineteen-story structure of this kind with 63 columns only 25 are continuous from bottom to top. In another house of sixteen stories only 6 of the 58 columns run from footings to roof without offsets. Special study must be given to each problem as it arises. The same difficulty occurs in adjusting wind stresses with the moment-distribution method as with other methods.

Professor Cross has a clear idea of the real problems of windbracing. In his book "Continuous Frames of Reinforced Concrete" he writes, "The chief function of the present discussion (on wind stresses in multi-story buildings) is to consider the problem in indeterminate structures involved. The problems of what wind pressures should be provided for and of how they would best be provided for are more important."

In conclusion, the distribution of fixed-end moments is a powerful tool for the solving of problems involving continuity of beam or column action. The methods originated and sponsored by Professor Cross will come more fully into their own when those who have been taught them in college days enter the field of action as designing engineers.

# Highlight Topics at the Detroit Congress

## Excerpts from public addresses and technical papers at the highway and building congress, Jan. 16-21 at Detroit, Mich., of 22 construction organizations

URGING its claim as a militant agency for bringing back business and relieving unemployment, construction in its congress last month offered a wealth of economic, business and technical evidence of advanced thinking. Much of this has been made plain in the extended report of the congress activities in our issue of Jan. 26. Much remained that could not then be told—probably can never be told because energy of spirit and purpose cannot be measured and defined by words.

In the pages that follow an attempt is made to pick up some of the loose ends of opinion and fact. It does not make an organized narrative; it merely lifts up into clear vision some of the inspirational thoughts of leaders in construction and a few of the facts that construction presents in proof of its recognition as a creative force for work relief and social improvement.

—Editor.

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**Overbuilding Denied**—It cannot be said that the country is overbuilt as long as our national road system is only one-third improved, and only 20 per cent of the improved roads have a permanent road surface.

It cannot be said that the country is overbuilt as long as the public water supply is lacking in the public health standards of purity or in ability to meet peak volume demand; as long as we continue to pollute the sources of pure water supply by using them as carriers of raw domestic and industrial wastes; as long as our people are restricted in social and business activities by outmoded and inadequate public transportation facilities; as long as we permit the existence of slum areas wherein immoderate rents are exacted for antiquated housing accommodations, nor as long as we permit unrestricted multiplication of the deadly grade crossings of railroads.

The inescapable demands of public services in which there is an accumulated deficiency of more than two years normal requirements can now be satisfied at a cost that justifies pledging future income, even if the boldest of emergency measures were not amply justified by the imperative necessity of immediately creating productive employment.

J. P. HALLIHAN,
*Chief Engineer, Detroit Rapid Transit Commission.*

**Construction Needs to Fight** — Thus far, we have failed in our opportunity, failed in our duty. What shall be our further course? I plead for militancy, for shouldering our responsibility to the public and expressing that responsibility vigorously.

Note what other large industries are doing. There are others worthy in size to be classed with ours—farming, the railroad, the automobile industry.

Farming surely is unified and assertive. There is no one in this country that does not know today the plight of the farmer.

The railroads have formed themselves into battle array. Their case is vividly put in the press in posters, before chambers of commerce and other bodies. They are fighting tax reduction; they are vigorous in demanding regulation of trucks and buses.

The motor industry more than any other stands out for its aggressiveness. It proclaims faith in America, faith in an economic hereafter, determination to entice lazy dollars out of hiding by offering superb values. If it gets the consumer dollar rather than we, impartial judges must say that the reward has gone where it belongs. Its leaders are still salesmen. They believe in aggressiveness. They have faith that human minds can still be influenced.

What should our objective be? My answer is: To sell construction to the public, to build business for the industry, to create demand for construction work. This is a project which the manufacturing group can understand and which their selling genius can accomplish.

E. J. MEHREN,
*President, Portland Cement Association.*

**Roadbuilding Gives 3,500,000 Jobs**—The jobs of 3,500,000 men are today at stake in the continued improvement, maintenance and use of highway transportation. They are threatened by increased motor, taxation, diversion of funds, opposition of other transport agencies and even the misunderstanding of friends.

One million men gain a livelihood from road construction and maintenance.

Two and a half million men are employed in the use and service of the motor vehicle, exclusive of its manufacture.

Roadbuilding has been one of the most effective means of relieving unemployment and at the same time providing a needed economic service.

M. L. PULCHER,
*President, Federal Motor Truck Co., Member Motor Truck Committee, National Automobile Chamber of Commerce.*

**County Work Relief**—Counties should so plan their road programs as to aid the employment condition. Public construction ought to be confined to projects which are at least value-producing. Road construction properly located and efficiently performed generally employs more labor than any other public work.

The projects best suited for county work are clearing of rights-of-way; cleaning ditches and culverts; grading, and widening shoulders and pavements; clearing all obstructions for proper vision; widening curves; sloping banks; sewer work and drainage problems.

The nearest approach to harmonizing the cry for more relief aid by employment and the insistent demand for lower taxes is in selecting such projects for relief work as are necessary and needed work, and in putting competent technical direction in charge of all operations. Projects should be a part of an anticipated public program and not "made" work for the sole purpose of taking care of the unemployed.

J. W. MAVITY,
*Chairman Committee on Public Relations, County Engineers Division A.R.B.A.*

**Exalted Road Tax Piracy**—New York motorists lost $51,000,000 in 1932. This vast sum, along with another $42,000,000 was paid into the state treasury in the form of road earnings—gas tax and license fee incomes. The $42,000,000 was used for state and county highways in the manner prescribed by the state laws. The $51,000,000 taken from motorists was not budgeted to highways but was used for all the miscellaneous activities participated in by the state.

On reasonable ground, the road users of New York object to this misuse of their money: (1) Diversion places an unfair burden on motorists alone which should be borne by the public at large. (2) New York road users not only pay all the costs of state highway construction but also more than one-third of local road costs. To ask them to pay $51,000,000 of other government costs is unfair and detrimental to highway transportation. (3) Diversion throws into the discard the principles upon which road-user taxes are based and violates the state laws. (4) Diversion reduces jobs and therefore is not in keeping with the federal program of unemployment relief.

THOMAS E. WRIGHT,
*Executive Secretary, New York State Construction Council.*

**An Engineer's Problem** — Roadbuilding and maintenance are an engineering problem. The days of the horse and buggy are gone, and we are now confronted with an entirely different condition in roadbuilding. No longer can the building of roads be placed in the hands of men who know nothing of present-day requirements. With present methods of transportation, attention must be given to location, grades, road materials, and the utilization of them; the character and amount of traffic, and a thousand and one things that enter into modern economical construction. The ordinary man and the politician know nothing of these things, because they have not made a study of them.

Then, it follows that the engineer should be in charge of these operations. Never in our history has it been more important than now that our county road commissioners select a competent engineer as the executive officer—the operating head of the organization in charge of all road work.

J. W. MAVITY,
*Chairman Committe on Public Relations, County Engineers Division, A.R.B.A.*

**National Planning** — Construction in this country has more or less been without plan ~~or purpose.~~ Housing and transportation, public works and commercial enterprises have largely grown "just like Topsy."

Pioneering days are over in the United States. We have explored to the very

Clear them of what?
How many years in advance of highway construction?

limits of our boundaries. We have ~~used and~~ abused our natural resources. Like grasshoppers, we have been good on distance but poor in direction. We have reached the stage, therefore, where national and community planning is essential for the guidance of the construction industry. Every city, county, district, region and state, as well as the nation itself must presently plan its progress, or there will be no progress. It will no longer suffice to raze our old structures *merely* to raise new ones in their places. The cost per capita of so doing, whether expressed in terms of public taxes or private rents, no longer justifies such procedure.

Regulation is the order of the day. Every industry must either assume its inherent obligation intelligently to regulate itself, or perhaps will, to its sorrow, find itself regulated by legislation. As individuals or as individualistic national associations, constituent elements of the one construction industry, we have, as history has sadly indicated, only worked at cross-purposes. In union there is strength, and thus through united effort there is a sound solution. "United we stand, divided we fall" is just as pertinent to the construction industry today as when shouted nearly a century ago.

A. P. GREENSFELDER,
*Second Vice-Chairman, Construction League of the United States.*

**Advance Planning**—Advance planning of public works will:

Lend itself to holding public expenditures within the financial means of the community, provide a reserve of borrowing power which will be available for use in emergencies, and thus insure continued unimpaired credit.

Extend the budgeting principle to embrace improvements and expenditures anticipated several years in the future, and coordinate them into a balanced community development program.

Furnish an estimate of income from the various sources of revenue which may become available to meet the financial requirements of the construction program, and thus indicate safe limits within which the construction program should be held.

Assist in determining whether projects should be financed through bond issues, special assessments, current revenues or otherwise in order that interest rates, debt service and taxes may be kept as low as possible.

Tend to avoid unjustifiable bond issues which may be voted in the enthusiasm of the moment.

Eliminate the wide fluctuations in annual expenditures so prevalent today and assure a more even tax rate.

Check over-zealous bureaus in their requests for funds.

Assist in properly appraising projects which may be curtailed or eliminated in accordance with changing needs or conditions.

Indicate the annual recurring cost of maintenance and operation resulting from the original expenditure and thus present a better picture of what the original investment entails.

Establish the ultimate total cost of a project rather than the cost of one phase of it.

Evaluate inopportune requests by groups of citizens or particular interests and will assist public officials in withstanding the pressure of such unreasonable demands for improvements ahead of schedule.

Permit projects to be withheld during boom times when the construction industry is overloaded and prices are high.

Provide public works which can be released during periods of depression to take advantage of low cost levels and sustain the normal construction volume of the community.

Afford a basis of analysis of physical improvements for grouping into categories where principles of discretion and priorities can be established for their inauguration.

Give the utility interests full knowledge of the sequence and location of improvements.

Permit detail plans and specifications to be prepared in advance.

Allow sites to be acquired in advance, taking advantage of favorable opportunities.

Assure more evenly balanced construction work throughout the twelve months of the year.

Enhance confidence in the administration.

Sustain the volume of public construction more rationally at about the same level year after year.

D. H. SAWYER,
*Director, Federal Employment Stabilization Board.*

## Congress Quotes

**"I plead for militancy, for shouldering our responsibility to the public and expressing that responsibility vigorously."**

**E. J. MEHREN,**
*President, Portland Cement Association.*

**"I am convinced that the advance planning of public works will be beneficial to the construction industry in proportion to the extent to which it is practiced, and I sincerely advocate this procedure as a striking contribution which can be made to the construction industry."**

**D. H. SAWYER,**
*Director, Federal Employment Stabilization Board.*

**"The coming new era of construction implies larger physical and human planning."**

**ROBERT D. KOHN,**
*General Chairman, Construction League of the United States.*

**"In five directions the Chamber of Commerce of the United States has shown its practical interest in construction: It aided the National Conference on Construction, it favored federal aid for roads, it opposed the diversion of the gasoline tax to other than highway use, it opposed the federal gasoline tax, and it favored R.F.C. loans for self-liquidating projects."**

**H. I. HARRIMAN,**
*President, Chamber of Commerce of the United States.*

**"Ours is not a finished nation. It can never be finished until our nation starts downward on the long road that leads to oblivion."**

**ALBEN W. BARKLEY,**
*U. S. Senator from Kentucky.*

**"Construction today is on the bargain counter."**

**B. L. KNOWLES,**
*Associated General Contractors.*

**"Let us throw into the construction industry that strength of mind and muscle with a purpose and goal to deliver ourselves from our present bondage and, without fear or favor, accept the challenge; have the courage to complete the task."**

**HENRY J. KAISER,**
*Associated General Contractors.*

**Prequalifying Contractors** — My experience with prequalification leads me to several basic conclusions:

1. Prequalification does not restrict competition, but rather encourages it, and improves the general grade of the bidders.

2. With prequalification, the same political pressure is not brought to bear upon an awarding official to prequalify a contractor who should not be prequalified, where he is perhaps one of ten prospective bidders, that is brought to bear on the same official to award a contract to an irresponsible low bidder.

3. It eliminates the "dark-horse" type of contractor who places a surprise bid on the blind chance that he may be low, and should he happen to be either peddles his bid to the banks for financial assistance, or sells out to the next lowest bidder who may be responsible.

4. I believe the greatest advantage of prequalification is that the awarding official secures by this method the truth about the proposed bidders, which truth he rarely if ever obtains under the post-qualification plan when he endeavors to look up the record of the low bidder.

I will not concede that prequalification prevents or retards the logical growth of any contracting firm from securing bigger work than they have heretofore handled, if their ambitions are well directed and within reasonable bounds.

COL. C. E. MYERS,
*Consulting Engineer, Philadelphia, Pa.*

**New Understreet Hazards**—Many utility companies are backward in recognizing the effect of changed type and speed of modern traffic. The same depth of cover or cushion is expected to serve as well now as it did twenty years ago. Another item which must be considered is the change in type of construction equipment. The introduction of heavy duty trucks, truck mixers and similar equipment has put upon these structures a greatly increased requirement as to stability. It is not at all unreasonable to assume that in many instances subsurface structures are materially weakened before the new pavement, under which they are located, is completed.

HARRY L. SHANER,
*Committee on Subsurface Street Structures, City Officials Division, A.R.B.A.*

**Cost Burden of Parking** — A parked car occupies approximately 156 sq.ft. of street space, having an average value on Fifth Ave., New York, of $34,000. At 5 per cent annually the carrying charges on this property are $1,702.50, which is equal to a monthly charge of $142.00, roughly ten times the cost of parking in a modern storage garage.

A recent study made in Los Angeles, California, shows that the average daily purchases of the occupants of 4,498 parked cars in the central business district amounted to $2.15. The Los Angeles analysis further shows that if the total daily business brought into the area by parked automobiles were divided equally among all establishments in the area, the value of the

average parked car to the average merchant would be only 3.4 mills.

The outstanding conclusion that must be drawn from these studies is that the value of the street space occupied by automobiles in most cities is out of proportion to the benefits which accrue either to the owner of the vehicle or to the merchant with whom the owner is supposed to do business. M. O. ELDRIDGE,
*Chairman, A.R.B.A. Committee on City Traffic.*

**Poor Laws Penalize Trucks**—By their lack of uniformity and disregard of scientific and economic fact, legislative restrictions on motor transport vehicles now in force in the states militate against efficient transportation and thus retard economic recovery. In this indirect way and in several direct ways the same situation presents problems to truck builders. Variations in state requirements necessitate undue diversity of designs, present difficult engineering problems, discourage enterprise, threaten the American system of production and penalize good engineering and sound manufacture. MERRILL C. HORINE,
*Sales Production Manager, International Motor Co.*

# *Letters to the Editor*

## Praise for the Corps of Engineers

Sir—The stand of *Engineering News-Record* in the editorial "Unwarranted Indictment" is to be commended. As a civil engineer I have for many years been in contact with the officers of the Engineer Corps, their construction operations, their engineering reports, estimates of cost and their recommendations. I have disagreed with and opposed some of their findings, but my intimate review of their work supports the assertion that the Engineer Corps has been loyal to public interests and economical in expenditure of government funds.

The unblemished record of the Corps of Engineers ranks first in the integrity of any group of public officials. Its members are an honor to the engineering profession. The derogatory statement of American Engineering Council does not reflect the opinions of the members that the Council is supposed to represent. L. K. SHERMAN,
Chicago, Ill., Jan. 10, 1932. President, Randolph-Perkins Co.

## A Suspended Tunnel

Sir—For the past 30 years or more at intervals there has been talk about either a bridge or a tunnel to cross the Straits of Mackinac, but no real proposal has been brought forth. Thirty years ago, when I was with the Copper Range R.R. Co., I recall someone conveying the information that railroad engineers had made soundings some years previously and had found that the great depth of water and accumulation of silt would render a tunnel prohibitory in cost. Also within the last few years the subject of a bridge was mentioned, but no doubt the great cost and length combined with the great depth and expected character of the bottom were deemed prohibitory.

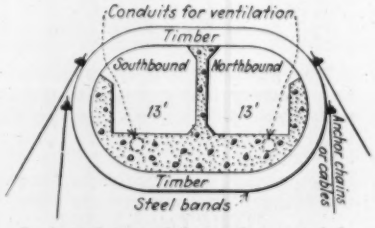
At the present time the state has very efficiently operated ferries plying between St. Ignace and Mackinaw City, but it is a reasonable assumption that in a very few years ferry transport will be wholly inadequate to meet the demand for rapid movement of cars across the straits.

In order to meet this difficulty and provide a means of keeping abreast of the great advance in transportation, I have devised a method of crossing peculiarly adapted to that location. This plan for crossing a deep channel of water is not altogether original. A proposal of a similar nature but different in detail was made 40 years ago for the English Channel. I find also that a Swedish engineer, named F. E. Strom, procured a patent in the U. S. in 1890 for an under-water crossing for deep water, also embodying a similar idea but differing in detail.

This proposal reduced to a few words consists in constructing a tube to be held by anchors at a sufficient distance below the surface not to interfere with navigation. Ordinarily 40 ft. would be sufficient for this, but at the Straits of Mackinac it would be better to allow a clearance from 50 to 60 ft. on account of ice. The accompanying sketch will convey the general idea. It will be noted that I have tentatively shown a double roadway, each lane 13 ft. wide to provide for one-way traffic in each roadway.

In order to assist as far as possible the labor situation in Michigan, nearly all the material required would be produced in this state. After studying the stresses to which such a tube would be subjected, I find that lumber could be used in the shell, that there would be considerable cribwork, viz., timber cribs filled with rock in the approach to shore ends and in the protection to the tube where it would be subject to wave action. This would require roughly about 100,000,000 feet b.m.

Of course, every engineer who notes




Section of suspended tunnel proposed for the Straits of Mackinac.

that this tube would be held at a distance of 60 ft. below the surface will say at once that timber would not stand the load, as it would be stressed at right angles to the grain, under which condition in engineering we only allow from 150 to 300 lb. per square inch, depending on the kind of timber; but here is where I think that I have an idea which is actually original. Before the timber was put into the structure it would be compressed under a pressure somewhat in excess of the pressure that it would have to sustain in the tube. Thus it would not matter what kind of timber would be used, anything found in woods which will make, say, a 6x10x16-ft. piece. Cedar would be excellent as it is so easy to work. I have a piece of cedar on my desk which was subjected to a pressure of 6,000 lb. per square inch across the grain; it was originally 1¼ in. thick, it is now ⅝ in., and the grain is as close as very hard wood. If I soak it in water, it will return to its original size, but if I confine it, the size will remain as it is. I have a small tube built up of cedar staves, each of which was compressed under 4,000 lb. per square inch. It is bound by steel straps, the latter have to be capable of resisting the tendency of the wood to expand when wet, but it has been immersed in water for some time without alteration. The expansion of wood in the direction of its length is only about ½ in. per mile per degree, so in the whole distance it would amount to approximately 2 ft., and this could be taken care of in the joints.

However, there is no use in entering into details of construction and placing into position here. Suffice it to say that there is nothing very formidable about the whole undertaking, as every feature could be worked out and executed with precision. T. R. HASLEY,
Menominee, Mich., Oct. 31, 1932. Civil Engineer.

## Goldbeck Pressure Cells Are Reliable

Sir—In his article on "Record Earth-Pressure Testing Machine" (*ENR*, Sept. 29, 1932, p. 365), Dr. Terzaghi remarked that he had no success with Goldbeck pressure cells for recording earth pressures. This is directly contrary to my experience with these pressure cells, and I wonder if the trouble might not have been in the manufacture of the cells themselves, or due to improper installation.

After careful investigation of the Goldbeck pressure cells, about the year 1918, we decided to install them in the cores of the flood-control dams of the Miami Conservancy District. This was done, and after we learned the trick of proper installation under the unfavorable conditions presented by the hydraulic core, we found that the cells gave very satisfactory and reliable results.

In our preliminary investigations we

came to realize that the manufacture of the cell itself was quite important. Although not a complicated job, it required expert workmanship, and fortunately we were able to obtain our cells from a man who had made up many of them previously for Mr. Goldbeck. All of these cells were tested under water before they were installed, and they registered correctly.

Because of the unusual and severe conditions under which these cells were used at our dams, we had some things to learn about proper methods of installation. In a paper published by the American Society of Civil Engineers (*Trans.*, Vol. LXXXV, 1922, p. 1190) I described the difficulty we had with our first installations and the methods used for improvement. These troubles with installations were, of course, due to no fault in the cells themselves, but rather to our lack of foresight in anticipating what later seemed to be obvious requirements.

The installation of eleven of these cells at the Taylorsville Dam was made after we had taken advantage of our earlier experience, and the records obtained at Taylorsville have been satisfactory and reasonably accurate from the beginning. These cells were installed more than ten yearss ago. They gave consistent and satisfactory readings during the whole construction period and have been read from time to time since construction was completed. Duplicate installations at various points have checked each other within limits easily explained by variations in the material itself.

At the Tieton Dam of the U. S. Reclamation Service, Goldbeck pressure cells installed in the hydraulic core gave satisfactory results as noted in *Engineering News-Record*, Sept. 30, 1926, and Dec. 18, 1930, pp. 954 and 955.

I have a firm conviction that the Goldbeck pressure cells, when carefully manufactured and properly installed, may be depended upon to give satisfactory and reasonably accurate records of earth pressure under almost any working condition.

CHAS. H. PAUL,
Consulting Engineer.

Dayton, Ohio,
Nov. 9, 1932.

* * *

Sir—The article entitled "Record Earth-Pressure Testing Machine" by Dr. Karl Terzaghi (*ENR*, Sept. 29, 1932, p. 365) gives an interesting account of the splendid earth-pressure testing machine that has been completed at the Massachusetts Institute of Technology.

In one of the concluding paragraphs, however (p. 369), the author states, "In contrast to the satisfactory service rendered by the scales, the Goldbeck pressure cells were found to be utterly unreliable."

During 1930 and 1931 the state highway board of Georgia used a number of the Goldbeck pressure cells in determining earth pressure from fills and "back roll" around concrete end bents. While the results from some were somewhat erratic, on the whole the pressure cells gave good results and I feel justified in stating that, with limitations that are to be expected for equipment of this kind, the Goldbeck cells can be and have been used satisfactorily.

SEARCY B. SLACK,
Bridge Engineer,
State Highway Board of Georgia.

Atlanta, Ga.,
Nov. 22, 1932.

## Keep in Circulation

Sir—During the past year my experience in this business of earning a living has been interesting and surprising in a good many ways. Thrown out of work a year ago, I naturally faced the immediate future with a good deal of trepidation. This was my first experience in such a predicament. I had always worked in an office, one office in fact, so that I had very few contacts on the outside. I had never done any work but engineering.

Feeling that it was a waste of time to look for work in engineering, I cast about for something else. The market was, and still is, flooded with the generous offers of manufacturers and business men to sell on commission. You provide your own expenses and drawing account and the company will pay you a commission on what you sell. I thought I might as well try something of this sort, as selling would be a good experience even though I should make only traveling expenses.

It has always been my intention to build up an engineering practice of my own. Consequently I chose a selling line that would take me into the offices of architects and builders. The product chosen also is sold directly to home owners, but I have never made a practive of pushing doorbells, knowing from experience the cordial reception received in most cases.

And so for the past year I have been circulating around the surrounding territory trying to sell and at the same time making contacts. From this experience the lesson that has been impressed on me more than any other is to keep in circulation. You would be surprised at the unlooked-for opportunities that crop up. You run into propositions in the most unlooked-for places. I did a fair-sized engineering job for one architect that happend to be a godsend. I walked into his office as he was about to call in another engineer. By convincing him that I could do the work I got the job. During the progress of the job I earned some money from the reinforcing bar company and the steel fabricating shop by detailing some of their work. I also received pay for shop and field inspection of the structural steel.

As a result of this job I expect to get others when conditions improve. Many helpful contacts were established, and probably many people heard of me that never had before.

But this was not the only work picked up. There were probably five or six other small engineering jobs that were encountered. Most of this work was done for pay. One or two very small ones were done for good will. If I had asked for pay, I wouldn't have done the work, and by putting in a few hours of my time, which wasn't worth anything to speak of, I have clients whom I feel will more than repay me in the future for my efforts.

Through my keeping in circulation I sometimes hear of leads for both contractors and architects. By telling them about these I build up good will, thereby insuring for myself any engineering work that may come along.

Of course I have not made a living at this game. I have made a good many sales of my specialty. Those commissions have paid my traveling expenses and my rent. I should say that during the past year I have made 60 to 70 per cent of a living. However, there are several projects pending at the present time. If a few of these break in my direction, I won't have to worry for the next few months. Very seldom a month goes by without the occurence of three or four unlooked-for developments.

Money that now has to be drawn from the bank for living expenses I figure to be an investment in my future in this particular locality. I can see no reason, barring unforeseen circumstances, why I shouldn't be in a position to earn a good return on this money when building improves. I don't think my time and money will be wasted.

Aside from the financial returns, the business of keping on the go is a good worry absorber. You have something to think about, something to plan. Brooding over your troubles around the house is a sure morale killer. So keep busy, forget your troubles, keep smiling, make contacts, keep your ears open, follow every lead to the end, and above all —keep in circulation.

ANONYMOUS.

## Heat Generated by Concrete in Setting

Sir—I recently came across some old specifications of an eminent English dock engineer who was accustomed to build dock walls 20 ft. to 30 ft. thick. His requirements were to place cement on wooden platforms 4 to 6 in. thick and to have this cement turned over twice daily for three days before using. I have never seen any other specifications in which this was required. I do not now recall the name of the engineer. Possibly if this were done for concrete in thick reservoir or other walls, it might cause the cement to generate less heat in setting.

WM. A. WILSON.

Santiago de Cuba,
Nov. 18, 1932.

# Engineering News-Record

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FEBRUARY 9, 1933 Volume 110 Number 6

### *Prospects for Construction*

In estimating the year's construction last week we ventured only a broad guess, for any forecast at this time has to reckon with extreme uncertainties. Prospects have not become measurably more definite since then. City and state budgets are progressing but slowly, under a pressure for curtailment that does not discriminate between expense and capital investment. Industry and utilities mark time. Congress has not solved the problem of R.F.C. stagnation, though there have been encouraging hearings on liberalizing amendments to the Relief Act. This indecisive drifting is a survival of last year's opposition to public-works employment. While the same tendencies may continue to paralyze initiative, the bond market is becoming strong and there are indications that the necessity of getting work going is being realized widely. The outlook for construction may therefore improve as spring approaches, but until more definite evidence appears our forecast of two and a half billions for the year stands as the best estimate now possible.

### *Construction Shows Fight*

Definite indications of a new popular sentiment in regard to construction appear in the vigorous opposition developing in a number of states in which legislatures are proposing further diversion of roadbuilding funds to direct relief. Usually joined with proposals to increase the gasoline tax rate, these diversion proposals are encountering opposition on a broader front than has ever before been active. Contractors and materials interests specifically dependent upon construction no longer stand alone. The battlefront has been strengthened by the oil and motor-car interests, by the automobile associations and by the farm granges; the latter see their hopes for farm-to-market roads go glimmering with increased diversion of road funds. Real hope lies in this awakening to the value of construction for work relief. But the forces against it are still so powerful that every reserve of engineering and construction should be brought into action to assure forward movement.

### *Better Late Than Never*

Following the example of more enterprising states, the New York authorities have just set up a state board to promote the progress of all R.F.C. construction loan applications. Up to now the state has taken no advantage of Title II of the Relief Act. Though it had available many large projects of useful character and revenue-producing power such as toll bridges and large water improvements, it made little effort to utilize the Act as a source of employment for its growing masses of jobless workers. It even permitted petty bickerings and small-caliber real-estate selfishness to hold up some admirably planned and beneficent housing projects that sought the aid of the Act. The new state board may succeed in removing some of the causes of the past delay and inactivity. Thus we have progress in sight, though it comes late in the day. The influence of the board may also help the state government to realize the harm that is likely to follow from plans to throttle road construction. The board can show the folly of such procedure, for there are men of intelligence and energy on the board, men who know what employment can do to rebuild business.

### *Bay Bridge Goes Ahead*

With commendable speed the California legislature removed the last barrier delaying active start on the gigantic San Francisco-Oakland Bay Bridge project. The passage of the group of six bills required to secure the approved R.F.C. financing, without a dissenting vote in either house, probably constitutes some kind of a legislative record. Merit, financial feasibility and recognized public advantage not only to the immediate area but to the entire state undoubtedly had much to do with the unanimity of opinion. It is significant that the bridge that has been discussed and planned by these communities for more than half a century is now to become an active development at a time when it will produce a badly needed incentive toward business recovery in that area. And no less will its influence extend over a much broader territory. The start of a $75,000,000 construction project, with its requirement of 190,000 tons of steel, 1,000,000 bbl. of cement, 400,000,000 b.ft. of lumber and other items in proportion, may well be looked upon as a milestone in the present critical period of the construction industry.

### *Flat-Slab Developments*

Minimum headroom encroachment and simple formwork for construction, coupled with strength and rigidity, constitute advantages that the concrete flat-slab structure has been able to contribute toward the solution of railroad grade-crossing problems. An ingenious piece of designing on the Weequahic Park underpass of the Lackawanna in Newark, N. J., has added another advantage—namely, elimination of the usual gravity abutments and their considerable amount of excavation. Instead of abutments a line of columns is substituted over which the slab is continued in cantilever projection. Then to give this cantilever rigidity and some live load from earth backfill, its end is turned down at a right angle. The designer calls it a "depending" slab. The columns are made short and rigid by setting them on a deep-T-beam footing. The underpass, indeed the whole three-level layout of which it is a part, is a reminder of the economies inherent in thoughtful design. Since grade-elimination work is certain of continued expansion, it offers one of the most fertile fields available for design ingenuity.

### *No Time For Fooling*

Disgust and impatience is the public's reaction to the petty jurisdictional dispute that threw 600 men out of work for several days recently on the new post office at Washington. Thousands of hours of much-needed work were lost by innocent workmen while two trades foolishly fought over

the right to turn an electrical switch twice a day. The switch controlled two motor-generator sets furnishing welding current to steamfitters. Hoist runners claimed it was their right to throw the switches—a claim disputed by the steamfitters. Truce was declared only when the generators were removed from the job and welding was temporarily suspended. Organized labor at all times has an obligation to prevent jurisdictional disputes from interfering with progress of work, but in the stress of present times this obligation acquires vastly greater force. Neither employer nor the public is in a mood to tolerate jurisdictional strikes, and labor's interest is no less obvious. With every working hour precious to those with jobs, this is no time for fooling.

## City Growth and Decline

FOR the past few decades population in this country has been concentrating in the suburban areas adjacent to our larger cities. Students of population growth, who have for a number of years called attention to our increasing degree of urbanization, to the drift of population toward the cities, have quite recently made further data available showing that the greatest rate of increase the country over has been registered by the suburban communities. On the other hand, those familiar with municipal problems have been aware of centrifugal forces which operate to depopulate the older areas of a city and create new population centers in the outskirts. An accurate measurement of this latter tendency is given in this issue by Howard W. Green in his discussion of city growth and decline.

The data presented by Mr. Green show that the exodus to the suburbs increased between 1910 and 1920, the period when the private automobile and the paved thoroughfare came into widespread use. Gradual encroachment of business and industry further detracted from the relative desirability of close-in residential districts, and the wealthier citizens rapidly moved to the suburbs. The premises they vacated became blighted areas of today, with their grave social and economic problems.

It is apparent that the typical form of city developed by present growth processes is far from economical to administer. Property values decline over a constantly widening area, involving serious loss of tax revenues to the city government, while the property of rapidly increasing value is found outside the city's political boundaries. Yet the services and physical facilities of the city must be proportioned to meet the demands of a population far greater than that of the city proper. Highways, water and sewer lines and other utilities become costly when they must pass through sparsely populated areas to reach their customers; their lengths and costs increase out of proportion to the increase in load upon them. Sociologists are agreed that the wellspring of delinquency and crime is in these blighted regions. Finally, the migration of a large proportion of the better educated part of the population to independent satellite communities robs the large city of potential political leadership that it can ill afford to lose.

Rehabilitation of the existing blighted areas is extremely difficult and waits upon modifications in our attitude toward control and development of real estate. But conscientious and farsighted zoning and planning can do much toward preventing further deterioration and stabilizing present values. Haphazard and undirected growth is too expensive to keep.

## New Business Sense in Construction

AFTER ruinous experiences, many separate groups of the construction industry are giving evidence of recovering business sense. They are taking definite action toward getting out of red ink by abandoning senseless competition and returning to businesslike price practices. In deciding to bid on a basis nearer to black ink than has been the case for the past year or two they are promoting the interest of the public as well as their own.

Recent contract bids, cement prices asked in state highway lettings and construction-machinery price practices are among the evidences of this return to business sanity. They indicate a definite trend toward business stability and away from the threat of complete industrial disorganization. If the interests concerned persevere in this trend, they will make a real contribution to the general strengthening of the price level and will help to protect the public from being deflated to bankruptcy.

Bids on public contracts have in recent months ended their steady downward movement. The strengthened cement prices that have prevailed since last fall met a crucial test in some large state and city lettings within the past few weeks and survived the test. Within the past few days a number of manufacturers of construction machinery have set up minimum prices for their main types of equipment and declared their intent or adhering to this minimum regardless of competitive price cutting. All these are indications that construction has decided to abandon short-selling and return to sound practices.

How much of this development may be credited to the new spirit awakened by the Detroit construction congress cannot now be appraised. But if the developments of the past few weeks are to be taken as a guide, other elements of the industry will soon take fresh courage and further help to revive an industry that was fast going into utter demoralization. Distress selling could not continue much longer without multiplying the evil showing of last year's business statements.

The new trend is one that everyone should welcome. It should be particularly gratifying to public officials and gain their full support in establishing solvent prices, for they preeminently are representatives of the public interest. Though they may be tempted to reject tenders, and, as was planned in one recent contract case, call for new bids in order to bring down prices, they can only injure the general well-being by such action. For it is quite clear that under present conditions any cost saving so obtained would be dearly bought by the further depreciation of values that it would produce. Restoration of price levels is the country's greatest need today, and all efforts to bring it about deserve universal support. For the same reason any effort to force prices still farther down is a blow at the general welfare.

The new business sense revealed by the above-noted events is an indication that construction has started back on the road to soundness. If advantage is taken of this beginning, and the new sense of unity of construction interests is utilized, the movement can even attain a momentum that will render a setback impossible. To this end we propose that every individual and group concerned in construction subscribe to the principle of placing prices on a solvent basis, regardless of competitive fears and temptations. By sweeping away losing prices they will initiate a new era of stability for construction.

# NEWS OF THE WEEK

## Large Loan Approved for Power Line from Hoover Dam

A LOAN of $22,800,000 to the municipal power and light system of the city of Los Angeles for the construction of a transmission line from Hoover Dam to Los Angeles, a distance of 271 miles, was approved by the Reconstruction Finance Corp. on Feb. 2. A double circuit transmission line for the transmission of 250,000 kw. of electric energy at 275,000 volts is proposed.

The making of this loan also assures the expenditure of $7,500,000 by the Department of Light and Power for its share of the cost of the power plant at Hoover Dam.

### Other loans approved

Other loans approved on Feb. 2 by the R.F.C. were $60,000 to the Reynolds Irrigation District, Melba, Idaho, for an extension of its water supply system; $10,000 to the town of Dufur, Ore., for extension of its water system; $27,500 to the town of Brookneal, Va., for a new water supply and distribution system; and $59,850 to the Chance Marine Construction Co. of Annapolis, Md., for the completion of docks and a breakwater in Annapolis harbor.

### Loans sought in New York

To facilitate action on loans for self-liquidating projects in the state of New York, the Governor recently appointed a special committee to seek out desirable projects and to assist in obtaining loans to finance their construction. The committee includes F. L. Cranford, a prominent New York contractor, John P. Hogan, chairman of the public works committee of the American Society of Civil Engineers, and Robert D. Kohn, past president of the American Institute of Architects.

Projects for which loans will be asked immediately are the construction of a second vehicle tunnel under the Hudson River at 38th St., New York, and construction of the Grand Island bridges across the Niagara River near Buffalo. Completion of the contract for the loan of $3,400,000 for a bridge across the Hudson River at Catskill, N. Y., already approved by the R.F.C., also is sought. Projects tentatively considered for early action are a slum-elimination project on the lower East Side in New York City, a causeway to Jones Beach and Long Beach on Long Island and a toll parkway along the top of the Palisades.

Bills have been introduced into the New York State legislature to permit cities and towns in the state to borrow money from the R.F.C. for the construction of a water supply and sewerage systems.

### Columbia Basin project

Application for a loan for the construction of the Grand Coulee dam of the Columbia Basin power and irrigation project is being considered in the state of Washington as a means of putting a large number of people to work promptly.

The application of the state of Maryland for a loan of $6,250,000 for construction of the Chesapeake Bay bridge is being actively pressed. The directors of the R.F.C. have set up certain conditions which the state hopes to meet, conditions similar to those imposed on the San Francisco Bay bridge project.

The city council of Toledo, Ohio, plans to withdraw its application for a loan of $8,000,000 for a new water supply from Lake Erie.

### Construction starts at Wilmette

Work was started Feb. 3 on the 6-m.g.d. water filtration plant at Wilmette, Ill., for which the R.F.C. granted a loan of $580,000 on Oct. 12, 1932. Bids were opened Nov. 15 and contracts were awarded Nov. 19 (*ENR* Nov. 24, 1932, p. 632) but work was not started pending a threatened injunction by the Shawnee County Club which owns property across the street from the site of the plant, alleging prospective damage due to the plant and violation of the zoning laws (*ENR* Dec. 1, 1932, p. 660). After full investigation by the legal departments of the village and the R.F.C. it was concluded to go ahead. The village bonds were purchased by the R.F.C. and $50,000 placed in a Chicago bank to the credit of the village Feb. 2. On the following day the Owen Engineering Co. which has the contract for the structures, started work. Application for this loan was made July 20, 1932, and ever since the officials have pressed the matter vigorously. The job will make available 180,000 man-hours.

## Company Formed in Cleveland To Supply Water to Industries

Application for a $2,925,000 loan from the Reconstruction Finance Corporation revealed the fact that there recently has been organized in Cleveland the Cuyahoga Valley Water Works, Inc., to furnish raw water for industrial use. The project for which financial aid from the government is sought contemplates an intake 70 ft. below the surface of Lake Erie at a considerable distance from the mouth of the Cuyahoga River, and the construction of a 10 ft. tunnel which would run directly south a distance of 19,000 ft. The plant would have a capacity of 600 m.g.d. and would serve an industrial district which normally uses 300 m.g.d. Pumping, however, would be done by the industries served.

The president of Cuyahoga Valley Water Works, Inc., is B. B. Quarrie, formerly general superintendent of the Newburgh plant of American Steel and Wire, and until recently president of Oliver Iron & Steel Company, Pittsburgh. Edgar B. Thomas, construction engineer of Cleveland is vice-president, and Raymond L. Davis, a law partner of E. H. Krueger, a former city utilities director, is secretary.

Wilbur Watson & Associates are in charge of engineering features of the project.

## Relief Act Changes Meet Approval of Senate Committee

INSTEAD of loans on projects that are self-liquidating in character a subcommittee of the Senate committee on banking and currency has agreed upon an amendment to the Relief Act which would extend such loans to projects that are "needful and in the public interest." After long discussions the subcommittee decided on this language rather than projects that are "needful and economically sound" or projects that "in the opinion of the directors would provide gainful employment." The amendment suggested by the subcommittee, it is stated, will make it possible for the R.F.C. to make loans for school buildings, libraries, court houses, subways, street paving, sewers, waterworks and the whole gamut of municipal activities.

The subcommittee refused to amend the act so as to permit loans to municipalities for the purpose of paying school teachers, policemen and other municipal employees. The subcommittee has agreed upon a liberalization of the provisions for low-cost housing that loans may be made for any period of years that may be decided upon by the board. Such loans are to carry an interest rate of "not more than one half of one per cent in excess of the amount that the money costs the government." The subcomittee also included a provision which will permit loans to private corporations for the purpose of developing cooperative community farming and crop marketing. Another addition to the bill would allow loans for the construction of aircraft suitable for overseas transport. This latter amendment is intended to pave the way for a loan for the construction of lighter-than-air ships to be used in regular service between north Atlantic ports and Europe.

### Engineers urge liberalization

Liberalization of the Relief Act, formally known as the Emergency Relief and Construction Act of 1932, was urged at hearings Feb. 2 and 3 by a long list of widely known witnesses, including A. J. Hammond, president of the American Society of Civil Engineers; Harrison P. Eddy, of the committee on waterworks betterments of the American Water Works Association; E. J. Russell, president of the American Institute of Architects; Martin Dodge of the banking and industrial committee for the Second Federal Reserve District; and George B. Walbridge, chairman of the legislative committee of the Associated General Contractors.

Mr. Hammond explained to the committee the six general principles underlying the amendments which had been worked out by the engineering societies. In the course of his testimony he stated that over two billion dollars worth of engineering construction could go forward if the self-liquidating conditions were liberalized.

"It is far better to tax for improvement which will raise the standards of living

than it is to tax and distribute the money in the form of a dole." This was the main contention of Mr. Walbridge, who urged that the restriction as to the use of tax monies be removed. He asked that the act be amended so that the maximum possible amount of relief funds distributed should be for work relief. In order to do that it would be necessary, he said, to allow the use of a part of such funds to go for the purchasing of materials. Many communities, he said, are unable to provide work relief because they have no local funds with which to buy materials that are necessary if work is furnished.

Mr. Eddy explained why the self-liquidating feature of the act and the provision with regard to tax funds had made it very difficult for communities to borrow for work on sewers and water supply projects. He stated that no loans will be made in New England until the rates of interest are lowered.

Otto T. Mallery, of Philadelphia, discussed the dangers of abuse in connection with the direct distribution of funds and urged that employment be furnished instead by means of public works programs.

Practically every witness suggested the removal of the restriction against the use of tax funds and urged a broadening of the self-liquidating requirement.

## Course in Advanced Hydraulics To Be Given at Columbia

The Department of Civil Engineering of Columbia University announces an advanced hydraulic study of open channel flow to be given during the spring session which opens February 8. The subject is to be given by Professor Boris A. Bakhmeteff of the department, and will cover in general the phenomena of non-uniform open channel flow and in particular such problems as the hydraulic jump and backwater curve. The class is to be held on Wednesday afternoons from 4 to 6, and is open to a limited number of special students. The fee is $30.

## Regulation of the Rio Grande Agreed to by U. S. and Mexico

A convention providing for the rectification of the Rio Grande channel in the El Paso-Juarez valley was signed between representatives of Mexico and the United States on Feb. 1. The plan agreed upon by the two governments embraces the building of a flood storage reservoir of 100,000 acre-ft. capacity 22 miles below the Elephant Butte reservoir and the straightening of the present river channel below El Paso, effecting a decrease in length from 150 miles to 88 miles, and the confining of the river in this channel between two parallel levees.

The layout of the straightening channel has been arranged to balance amount of land to be transferred from the sovereignty of one country to the other so that neither will lose any area by the change.

A more complete description of the work provided for in the convention between the two governments will be published in a subsequent issue.

## California Contractors Oppose Day Labor on Government Work

A declaration of war upon day labor or force account methods of performing work on government construction was made by the Southern California Chapter of the Associated General Contractors of America at its annual meeting held in Los Angeles Jan. 26. The meeting adopted three resolutions, the first addressed to the Metropolitan Water District condemning its day labor policy, the second specifically citing the Coachella tunnel work on which the water district has begun operations on a day-labor basis, and the third commending the engineers in charge of the work on San Gabriel dam No. 1 for letting the work by contract.

Lynn Atkinson was elected president and Frank J. Connolly was appointed manager to succeed Melville Dozier, Jr., who resigned last fall to enter private practice.

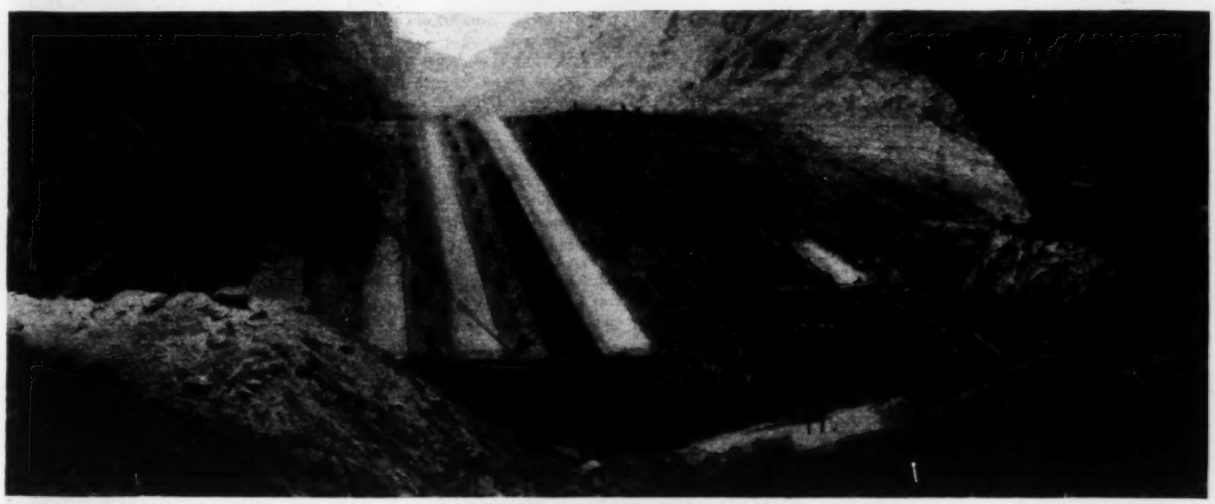
## County Manager Type of Charter Approved in California

The new charter of San Mateo County, California, incorporating the county manager type of administration, voted at the November election, has been approved by the state legislature. This is the first instance of county management government in the West and is believed to be the second in the country. The essential feature of the new charter is the provision for appointing a county manager by a four-fifths vote of the supervisors from a list of not less than two or more than five candidates selected by a special board consisting of the two superior judges, the superintendent of schools and two citizens. San Mateo County occupies the peninsular area south of San Francisco.

The manager appoints, with confirmation of the supervisors, the heads of the administrative departments. An important change is the centralization of all county road work under the engineering staff. All county officials are required to give full time to their work and are barred from private practice. Salaries are to be set by the supervisors, but a minimum is fixed by the charter.

## Detroit Sues Contracting Firm On Collapsed Southfield Sewer

As an outgrowth of the collapse of the Southfield sewer in Detroit in 1930, the city has begun suit to collect $900,000 damages from Julius Porath & Sons, the contractor. The city claims that plastering of the interior of the sewer as revealed in an inspection of the sewer by engineers following the collapse of a section of the sewer was not called for in the specifications and was employed to cover defects. The contractor's counter claim is that the city's specifications were not suitable for the character of soil encountered, also that the firm was not paid for its work until after it had been approved by the city engineer's office.



**UPSTREAM COFFERDAM FOR HOOVER DAM**

**Work on the upstream cofferdam for Hoover Dam has been pushed to the point where the concrete paving on the upstream face is well along toward completion. This picture was taken looking down the canyon toward the face that will have to withstand attack by the river during time of high water. A picture of the damsite showing the early stages of this cofferdam was published in the Dec. 15 issue, p. 704. The same issue contained a plan, section, and other details of the cofferdams in the river.**

## New York State Engineers Act on Legislative Matters

The New York State Society of Professional Engineers, at its winter meeting held in Albany, Feb. 4, approved drafts of an amendment to Section 300 of the state multiple-dwelling law to place engineers on a par with architects in acting as owners' agents. The society also approved several minor amendments to both the architects' and engineers' registration laws to clarify wording and improve the administration of those laws. The only significant change is one calling for elimination of the qualifying adjectives "professional" before the word engineer and "land" before the word surveyor in the section defining unlawful use of titles. As revised this section of the law will make it unlawful for a person to use the term engineer or the term surveyor in such a way as to give the impression that the person is practicing professional engineering or land surveying.

Section 300 of the multiple dwelling law was one of the chief sources of the recent unpleasantness between the architects and engineers in New York State. The amendment now proposed has the endorsement of the architects.

Resolutions were passed by the society urging federal appropriations for the completion of topographic mapping and endorsing the establishment of a federal department of public works. On state matters endorsement was given to the Desmond bills to enable municipalities in the state to borrow money from the R.F.C. for waterworks and sewerage systems financed out of service charges. Resolutions also were passed opposing unfair competition by state and municipal employees with engineers in private practice; urging the maintenance on the civil service list for four years of the names of men laid off during the present depression; and urging maintenance of planning work.

The society has enrolled membership of 2,313 of whom 1,720 are in good standing. The gain in 1932 was 329.

## Denver Sued by Builders of City-County Building

Two contractors on the new Denver City and County Building, Varnum and Bate of Denver, and the Fleischer Engineering Co., of Chicago, have filed suit against the city of Denver asking $41,000 damages. The contractors claim that the city failed to deliver the proper plans and specifications for the building and in consequence the Fleischer company's force was idle in Denver from Dec. 1, 1931, to June 17, 1932.

## Concrete Pavement Yardage

There is given below a tabulation of concrete pavement awards in the United States during the month of December, divided according to roads, streets and alleys and the total for the year, 1932.

| | Sq.Yd. Awarded During December, 1932 | Total Sq.Yd. Awarded for Year to Dec. 31, 1932 |
|---|---|---|
| Roads | 4,638,047 | 86,393,986 |
| Streets | 999,352 | 10,094,222 |
| Alleys | 11,972 | 339,269 |
| Total | 5,649,371 | 96,827,477 |

## Bonds Sold for Terminal Work

The Cincinnati Union Terminal Co. has informed the Interstate Commerce Commission that it will be able to finance construction of the union station by the sale of its own bonds. The company requested permission from the commission to issue $12,000,000 of first mortgage 5 per cent gold bonds for sale at 97½ to J. P. Morgan & Company and other banking houses to repay an $11,000,000 loan by the Reconstruction Finance Corporation.

When offered by the banking houses this issue was oversubscribed on the first day.

## Committee in Montclair, N. J., Reports on Town Economies

After an exhaustive study lasting several months the Citizens Survey Committee of Montclair, N. J., has submitted its report recommending various economies in town administration. In its inquiry the committee studied in detail the operations of each department of the town government for the purpose of determining how the cost of operation might be reduced. M. N. Baker, recently associate editor of *Engineering News-Record*, was the engineer member of the committee.

The detailed report of the committee is prefaced by a statement that the committee has seen no evidence of graft in the Montclair town departments. The economy measures that were recommended in detail comprise largely a series of moves designed to stop a number of small wastes, few of which are of serious magnitude individually.

Reorganization and unified control are recommended for the water department, which is described in the report as suffering from the lack of a single directing head for all of its activities. Possible economies in pumping through readjustment of the various distribution zones are recommended for consideration. The committee suggests that the health department laboratory should make the routine tests of water supplied to the town through the Wanaque aqueduct.

Reduction in the town budget for 1932 was borne 80 per cent by the department of public works. Few further economies were recommended for this department. The report included a warning that further neglect of street repairs will entail greatly increased future outlay. Making the removal of snow from sidewalks a responsibility of the householder was recommended. It was further suggested that the plan of charging sewer expense to individual users be considered by the town.

The setting up of a town planning board is recommended to conserve such valuable work as has already been done and to continue such work as future needs arise.

In financing, the committee recommended that the form of budget be changed so as to show the allocation of expenditures to various town departments and services. It further suggests that statements of outstanding debts and debt service costs by functions or purposes should be determined yearly.

The committee strongly recommends that tax due dates be made to synchronize with the town fiscal year and that taxes be made payable in monthly installments to prevent interest charges on tax anticipation notes.

## No Bids for Incinerators Submitted at Detroit

No bids were received by the city of Detroit under the plan of the department of public works for building, financing and operating a system of four combined garbage and rubbish incinerators. A number of requests for copies of plans and specifications were received from prospective bidders prior to the opening date, Jan. 18. Bids were asked based upon a rate per ton for disposal of garbage that would permit the plants to be turned over to the city fully paid for at the end of a period of seven years. Lack of bids under the plan that would have required private capital to finance the construction was attributed to adverse local reports on the city's finances.

A proposal that the city proceed to construct the plants on a work-for-tax plan was submitted to the city council. It is estimated that the entire $1,600,000 system could be constructed for an outlay of approximately $200,000 in cash. A way would be provided for delinquent taxpayers to work out their taxes or pay them in material used in the construction of the proposed incinerators.

The saving to the city from the operation of the four plants is estimated at $400,000 yearly, as compared with the present price.

Another possibility suggested by Commissioner of Public Works Laurence G. Lenhardt to reduce the cost of waste disposal to the city includes putting an item in the 1933 budget to finance one unit of the incinerators, following each year with succeeding appropriations; taking advantage of statutes which permit garbage disposal being placed on a public utility basis and thus seeking loans directly from the Reconstruction Finance Corporation as a public utility.

## National Hydraulic Laboratories to Exchange Research Data

By an arrangement recently made between the U. S. Bureau of Standards, the American Committee of the World's Power Conference and the University of California, the hydraulic laboratories in this country have been asked to submit quarterly reports to the hydraulic laboratory section of the Bureau of Standards in Washington upon the hydraulic research in progress and the research for which plans have reached a definite stage. On the completion of reports on research undertaken by these laboratories, copies will be filed with the Bureau of Standards. Each laboratory also will file with the bureau a report of its facilities for hydraulic research. In return the Bureau of Standards will make quarterly reports to the co-operating laboratories of the research in progress throughout the country and will catalog and file all reports submitted to it. Annually the bureau will send all co-operating laboratories a statement of the facilities in each of the laboratories.

If an arrangement for an international exchange of such information is completed by the World Power Conference, the Bureau of Standards will act as the clearing house for information from this country. O. C. Merrill, 405 Lexington Ave., New York City, is chairman, American Committee of the World Power Conference.

## Herbert Hoover Honored

Herbert C. Hoover was elected an honorary member of the Institution of Civil Engineers, Great Britain, at a meeting of the Institution held on Jan. 10. President Hoover is the only American among the honorary members of the Institution of Civil Engineers.

## Contract for San Jacinto Tunnel of Colorado Aqueduct Withdrawn

Contract between the Metropolitan Water District of Southern California and the Metropolitan Engineering Corp. for the construction of the San Jacinto tunnel of the Colorado River aqueduct which has been held up because of difficulties involved in obtaining the necessary material and labor bonds has been withdrawn by the district and the bid of the next lowest bidder, Wenzel and Henoch of Milwaukee, has been reinstated.

Bids on the Valverde and Bernasconi tunnels of the Colorado River aqueduct which were to have been opened on Feb. 1 have been recalled by the officials of the district and will be readvertised. It is stated that the readvertising will include changes in the specifications to protect the interests of the district and at the same time encourage more competitive bidding.

## Contract for Parker Site Dam on Colorado River Approved

A proposed contract between the United States and the Metropolitan Water District of Southern California for the construction of a dam across the Colorado River at the Parker site was approved by the Secretary of the Interior on Jan. 31. The dam is to form a reservoir from which water will be pumped into the aqueduct serving the metropolitan water district. It will raise the water level in the river 72 ft., making it possible to generate about 80,000 hp. below the dam, but because of the depth of the river valley at the site the dam will have a total height above foundation of about 270 ft.

The location of the dam and its general characteristics were given in our issue of June 16, 1932, p. 847.

Under the proposed contract the metropolitan water district will provide the money for the construction of the dam and power house, estimated to cost $32,000,000, and the dam will be built by the United States government which will retain ownership. The United States government also will retain the right to use half the power for the benefit of the Indians and public lands in Arizona. Statutory authority already exists for the construction of the dam to aid in the reclamation of the Colorado River Indian reservation.

In addition, the United States government reserves the right to control all water passing the dam and utilizing the top 10 ft. of storage capacity for regulation in connection with the Hoover Dam power operations and flood control. The district agrees to transmit Arizona's share of the Hoover Dam power, 170,000 hp., over its transmission line from Hoover Dam to the Parker Dam at cost.

Construction of the dam is expected to be undertaken during the filling of the reservoir behind Hoover Dam.

## SOCIETY CALENDAR

AMERICAN CONCRETE INSTITUTE, annual meeting, Chicago, Feb. 21-24.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, annual meeting, Chicago, March 13-15.

AMERICAN CERAMIC SOCIETY, annual meeting, Pittsburgh, Pa., Feb. 12-17.

NATIONAL BRICK MANUFACTURERS RESEARCH FOUNDATION, annual meeting, Pittsburgh, Pa., Feb. 12-17.

CANADIAN SECTION, American Waterworks Association, will hold its annual meeting at Ottawa, Ont., March 22-24.

SOUTHEASTERN SECTION, American Water Works Association, will hold its 1933 meeting in Albany, Georgia, April 4, 5, 6.

NEBRASKA ENGINEERS CLUB will hold its annual round-up at Omaha on Feb. 25. Elwood Mead, Commissioner of Reclamation, will describe the Hoover Dam work.

ENGINEERING COUNCIL OF UTAH has elected Fred H. Richardson, district engineer, Portland Cement Association, Salt Lake, as president, and Joseph H. Young, U. S. Bureau of Public Roads, vice-president. George M. Bacon, state engineer, is secretary.

SACRAMENTO SECTION, American Society of Civil Engineers, at its annual dinner meeting Jan. 26 elected W. Fitzhugh Turner, division engineer, Southern Pacific Ry., president for the ensuing year. The retiring president, Fred Grumm, gave a report on engineering activities in the country during the past year.

## *Personal Notes*

ROY WOODWARD of South Bend, Wash., has been named county engineer of Pacific County, Wash. BASIL MILLMAN has been named assistant engineer.

THOMAS O. HASLEY, a member of the contracting and engineering firm of W. J. Hasley Co., has been appointed director of public works of Allegheny county, Pittsburgh, Pa., to succeed FRANK J. CHESTER, resigned.

FREDERICK H. WEED has resigned as chief engineer of Gannett, Seelye and Fleming Engineers, Inc., of New York and Harrisburg. For the present his New York office will be at Room 1902, 25 West 43d St., New York City.

A. E. PALEN, district engineer of the United States bureau of public roads for Colorado, Wyoming and New Mexico, has been transferred to St. Paul, Minn., relieving E. O. HATHAWAY, retired. Mr. Palen's new jurisdiction takes in Minnesota, Wisconsin, North and South Dakota.

LLEWELLYN N. EDWARDS, Senior Highway Bridge Engineer, U. S. Bureau of Public Roads, sailed from New York January 20 to spend three months in the British Isles on research work relating to both early and recent developments in engineering. On February 15 he will read a paper before the Newcomen Society on "The Evolution of American Bridges."

WILLIAM BOWIE, chief of the Coast and Geodetic Survey's Division of Geodesy, has had conferred on him the Charles Lagrange prize by the Belgium Royal Academy of Science, Letters and Fine Arts. The citation was for "the best mathematical or experimental work constituting an important progress in the mathematical knowledge of the earth." The prize is 1,700 francs and was awarded to Dr. Bowie at the conclusion of an international competition. The specific work for which the the prize was awarded was the complete homogeneity that he obtained in the triangulation of the United States, Canada and Mexico.

## *Obituary*

FRANK E. JOHNSON, construction engineer, Syracuse, N. Y., died at Lake Worth, Fla., on Jan. 22, age 58 years.

JAMES M. WHITE, professor of architectural engineering at the University of Illinois and dean of the College of Engineering, from 1905-1907, died at his home in Champaign, Ill., on Feb. 6, age 65 years.

OSCAR EUPHRAT, a member of the structural engineering firm of Euphrat & Hanly, died at his home in Cincinnati on Feb. 2. Mr. Euphrat was one of the early proponents of quantity surveys as an asset to construction operations.

JOHN B. LORD, chairman of the board of Ayer & Lord Tie Co. of Chicago, died on Jan. 21, age 84 years. Mr. Lord's firm began the application of preservative treatment to railroad ties on a large scale in 1903 and since that time Mr. Lord has been actively interested in the development of wood preservation.

LEONARD M. WACHTER, sanitary engineer of the New York State Department of Health, died at Albany on Jan. 31, age 59 years. Mr. Wachter was a graduate of Rensselaer Polytechnic Institute and served as chemist in the water department of Albany from 1899 to 1906 when he entered the state service.

JOSEPH P. A. HART, president of the contracting firm of Hart & Early, subway builders, New York, died at the Johns Hopkins University Hospital, Baltimore, on Feb. 5, age 42 years. Mr. Hart began work as a construction engineer on the Catskill aqueduct in 1909 and subsequently was with the contracting firm of Smith, Hauser & McIsaac and then with the firm of Spencer, White & Prentis on foundation work at New York. In 1925 he organized the firm of Hart & Early.

C. D. EMMONS, president of the Hudson & Manhattan Railroad Co., New York, died there on Feb. 2, age 62 years. Mr. Emmons graduated in civil engineering from the University of Pennsylvania in 1892 and began work in the engineering department of the Pennsylvania R.R., subsequently going into street railway work at Lafayette, Ind. For ten years he was president of the United Railways & Electric Co. of Baltimore and became head of the Hudson & Manhattan Railroad Co. in 1930.

WILLIAM H. HENBY, president and general manager, St. Louis County Water Co., University City, Mo., died there on Jan. 20, age 61 years. Mr. Henby was graduated from Washington University in 1900 and began his engineering career on river survey work, later being associated with contractor firms as chief engineer. Subsequently he was in the St. Louis water department and in 1912 he became secretary and general manager for the St. Louis County Water Co. In 1926 he was made president.

# Brief News

THE RESEARCH INFORMATION SERVICE of the National Research Council is preparing a revision of its "Industrial Research Laboratories of the United States, including Consulting Research Laboratories," the fourth edition of which was published in 1931.

THE FLORIDA SUPREME COURT has before it a controversy as to who holds a valid franchise to build a toll bridge between the Florida keys on the road between Miami and Key West. George J. Rosenthal, Miami, obtained a franchise from Monroe Co. in 1931, and the Overseas Bridge Corporation obtained one from State Road Department in 1932.

AN ENGINEERING AND RAILWAY EXHIBIT is to be held at Chaio Tung University in Shanghai, China, March 30 to April 8, 1933, under the auspices of the Ministry of Railways. A booklet explaining the purpose of the exhibition may be obtained from the transportation division of the Bureau of Foreign and Domestic Commerce in Washington.

ASSOCIATED GENERAL CONTRACTORS OF IDAHO is a new chapter of the A.G.C. recently organized at Boise with A. G. Cornell, president, J. M. Sharp, vice-president, and Harold Quinn, secretary-treasurer. The menace to road construction in the state through the diversion of gasoline tax funds is stated as a reason for the formation of the chapter.

COMPLETION DATE FOR THE POWER project of the Rocky Mountain Power Co. at the outlet of Flathead Lake in Montana has been extended to May 23, 1935 by the Federal Power Commission. The license for the power company now calls for the completion of the installation of three units of not less than 150,000 hp. aggregate capacity by that date. Rights of local irrigation interests and the Flathead Indians are protected in the change in the power company's license. Construction of the plant was begun some time ago but little has been done in recent months on account of a great falling off in the demand for power

## Contracts and Capital

**CONSTRUCTION**

(Thousands of Dollars)

| | Weekly Average Feb., 1932 | Four Weeks | Week Feb. 9, 1933 |
|---|---|---|---|
| Federal government | $1,869 | $5,675 | $6,077 |
| State and municipal | 9,721 | 7,187 | 4,474 |
| Total public | $11,590 | $12,862 | $10,551 |
| Total private | 9,863 | 3,343 | 3,196 |
| Week's total | $21,453 | $16,205 | $13,747 |

Cumulative to date:

| | |
|---|---|
| 1932 | $136,488 |
| 1933 | 130,430 |

**NEW PRODUCTIVE CAPITAL**

(Thousands of Dollars)

| | Weekly Average Feb., 1932 | Four Weeks | Week Feb. 4, 1933 |
|---|---|---|---|
| R.F.C. loans made | | | |
| New capital issues | $15,750 | $6,700 | $17,400 |
| Total | $15,750 | $6,700 | $17,400 |

Cumulative to date:

| | |
|---|---|
| 1932 | $115,750 |
| 1933 | 42,600 |

R.F.C. self-liquidating loans:

| | |
|---|---|
| Approved current week | $22,957 |
| Approved to date (including 1932) | 172,206 |
| Actual loans made (including 1932) | 17,753 |

## *ENR* Cost and Volume Index

| E.N.-R. Cost | | E.N.-R. Volume | |
|---|---|---|---|
| **February, 1933** | **159.30** | **January, 1933** | **129** |
| January, 1933 | 158.44 | December, 1932 | 113 |
| February, 1932 | 161.82 | January, 1932 | 121 |
| 1932 (Average) | 156.97 | 1932 (Average) | 127 |
| 1931 (Average) | 181.35 | 1931 (Average) | 220 |
| 1930 (Average) | 202.35 | 1930 (Average) | 260 |
| 1913 Average | 100 | | |

# Engineering Contracts and Capital

A SHARP REDUCTION in state and municipal awards brought the total of heavy engineering construction contracts reported for the past week down to $13,747,000, the second lowest week of the year. The previous week's total was $21,291,000. State and municipal contracts for the past week fell off to $4,474,000, as compared with $12,072,000 for the previous week. The past week's total is the lowest reported for this class of work for years. Federal awards amounted to $6,077,000, a gain over the previous week's total of $5,069,000. Highway lettings totaled $2,178,000, the lowest in a year. Private contracts amounted to $3,196,000, about the average of the past few months. For the first time this year the cumulative total of all construction has fallen below that of last year. To date this year contracts total $130,430,000, as compared with $136,488,000 for a similar period last year. The average of all contracts let the last four weeks is $16,205,000, as compared with a weekly average of $21,453,000 for February, 1932. Only one large contract was reported last week, that for a navy hospital in Philadelphia, amounting to $2,588,000.

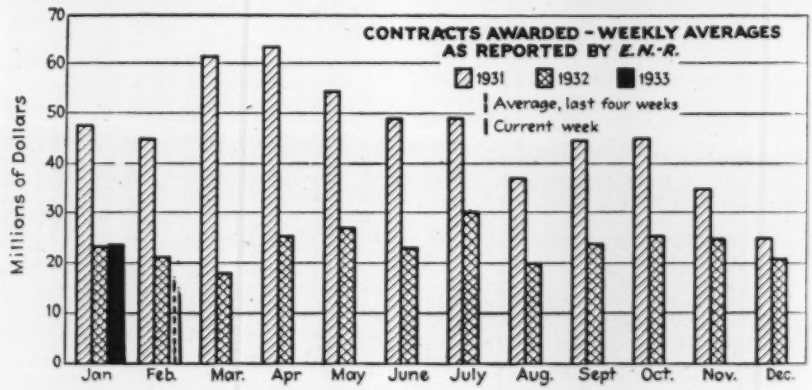
Proposed construction projects announced last week include a million-dollar brewery, Long Island City, N. Y.; apartments, Cincinnati, estimated at $1,000,000; reservoir and water mains, Cleveland, $4,000,000; a federal building, Indianapolis, $1,000,000; and a hydro-electric development in Virginia, estimated at $2,500,000. Bids will be received this month for apartments in Newark, N. J., $2,437,000, and for highways, Indiana, $2,100,000.

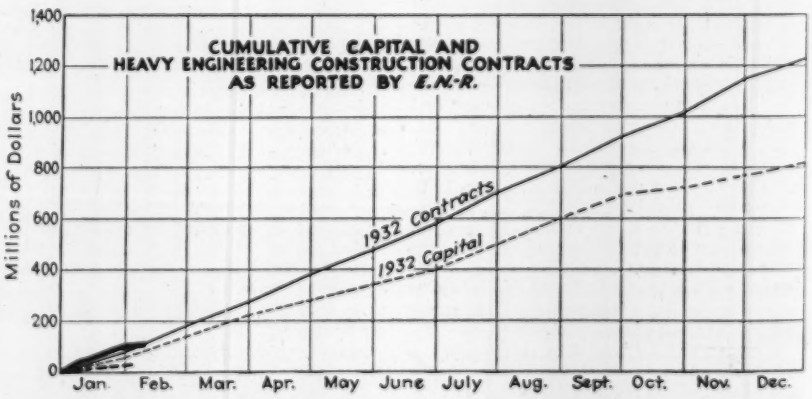
New capital issues reported for the past week were the largest yet this year, amounting to $17,400,000, of which $14,500,000 was private bond and preferred stock sales. The largest issue of the week was $12,000,000 of the Cincinnati Union Terminal Co.

### West coast lumber improves

Increasing production for the second consecutive week the 252 mills reporting to the West Coast Lumberman's Association operated at 20.7 per cent capacity for the week ending Jan. 14 as compared to 17.8 per cent the previous week. The report showed 82 plants operating and 170 plants down.

Inventories as reported by 130 mills were 19 per cent less than last year and unfilled orders increased one million feet from the past week. Reports from 178 mills indicated that new business was about 8 per cent over production.



# *Business Side of Construction*

## January Contract Awards Heavier Than Previous Month and Year Ago

HEAVY ENGINEERING construction contracts reported in January (four weeks) total $95,392,000, or an average of 23.8 millions per week, which is a considerable gain over the December weekly average of 20.7 millions and is slightly above the January, 1932, weekly average of 23.4 millions. The weekly average of contracts let during 1932 was 23.5 millions. However, the gain is entirely in the public works field, as the weekly average of private contracts in January, 1933, was 4.4 millions as compared with 4.6 millions in December and 9.9 millions in January, 1932. Highway lettings, amounting to 5.4 millions per week were almost double those let in January, 1932, but were slightly under the $6,000,000 average of the previous month. Industrial building contracts averaging 2.4 millions per week, were the highest of any month of last year except July. This work and waterways contracts, amounting to 2.9 millions, were just double those of the previous month. The highest gain of any class of work was registered by waterworks which averaged 5.2 millions per week, as compared with 1.8 millions in December.

In comparing January contracts with those of December on a geographical basis, gains were registered in the New England and Far West districts, the other four districts of the country showing a loss for January. Contracts in New England more than doubled in January as compared with December. In the Far West contracts averaged 9.2 millions per week, just three times the December average. This gain is due to the start of work on the Colorado River aqueduct in Southern California.

### Construction materials

*Portland Cement*—The portland cement industry in December, 1932, produced 4,238,000 bbl., shipped 2,835,000 bbl., from the mills, and had in stock at the end of the month 20,200,000 bbl. Production for the month showed a decrease of 28.9 per cent and shipments a decrease of 31.6 per cent as compared with December, 1931. Production in relation to capacity of the industry was 18.5 for December, 1932, 29.1 for November, 1932, and 26.4 for December, 1931. These figures are from the U. S. Bureau of Mines.

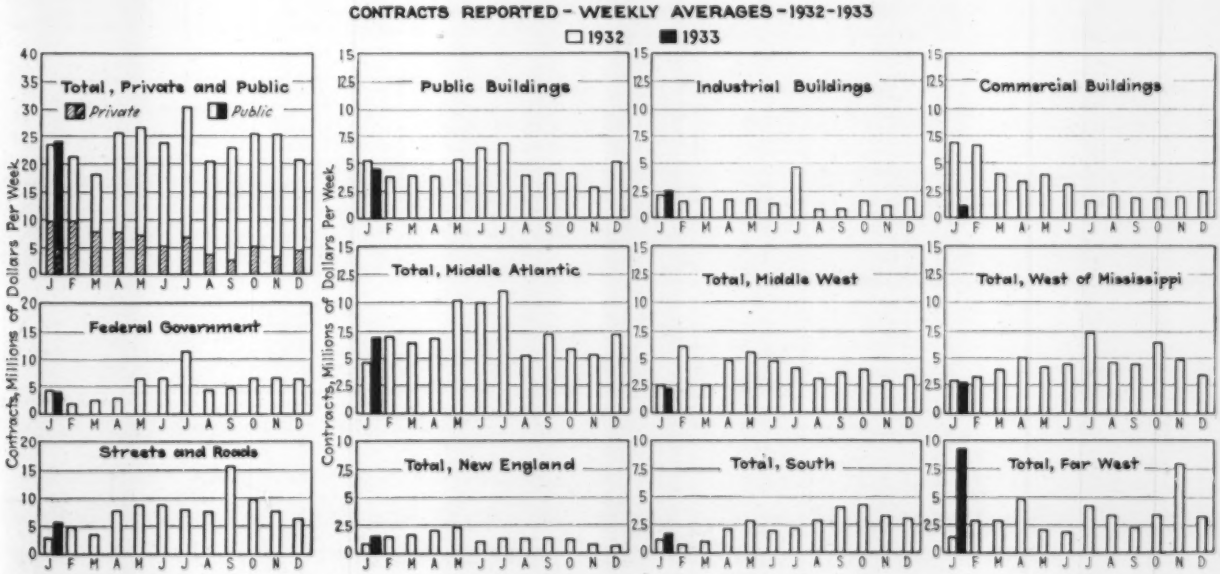
*Lumber*—Lumber production during January averaged about 17 per cent of normal, and about 44 per cent of the average production of the last three years. According to the National Lumber Manufacturers Association, production is being curtailed, continuing the practice of the past year, in an effort to reduce mill stocks. Shipment of lumber during January amounted to 114 per cent of production, and new orders received amounted to 120 per cent of production. Production of soft wood during the first three weeks of the year amounted to 228,067 M. bd.ft., which was 90 per cent of production for the same period in 1932.

*Steel*—The production of steel ingots at the beginning of the year was about 15 per cent of capacity. By the middle of the

ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN JANUARY, 1933

Four Weeks — Thousands of Dollars (000 Omitted)

| | New England | Middle Atlantic | South | Middle West | West of Mississippi | Far West | United States Jan., 1933 | United States Jan., 1932 | Canada Jan., 1933 |
|---|---|---|---|---|---|---|---|---|---|
| Waterworks | 1,091 | 372 | 49 | 217 | 338 | 18,547 | 20,614 | 2,129 | 101 |
| Sewers | 135 | 1,257 | 256 | 257 | 514 | 51 | 2,470 | 3,246 | 449 |
| Bridges, public | 231 | 1,077 | 569 | 628 | 1,287 | 855 | 4,647 | 3,936 | .... |
| Earthwork and waterways | 47 | 691 | 1,823 | 75 | 289 | 8,742 | 11,667 | 7,902 | .... |
| Streets and Roads | 1,575 | 4,036 | 2,212 | 4,845 | 5,067 | 3,981 | 21,716 | 11,699 | .... |
| Buildings, public | 163 | 10,818 | 480 | 192 | 1,115 | 3,003 | 15,771 | 20,648 | .... |
| Unclassified, public | 176 | 236 | 155 | 122 | 14 | 195 | 898 | 4,398 | .... |
| Total public | 3,418 | 18,487 | 5,544 | 6,336 | 8,624 | 35,374 | 77,783 | 53,778 | 550 |
| Federal government (included in above classifications) | 68 | 7,863 | 2,180 | 223 | 654 | 3,557 | 14,545 | 16,621 | .... |
| Bridges, private | .... | 817 | .... | .... | 215 | .... | 1,032 | 700 | .... |
| Buildings, industrial | 2,468 | 4,339 | 491 | 758 | 651 | 718 | 9,425 | 8,683 | 135 |
| Buildings, commercial | 195 | 2,743 | 110 | 305 | 570 | 350 | 4,273 | 27,506 | 117 |
| Unclassified, private | 25 | 967 | 198 | 1,241 | 393 | 55 | 2,879 | 2,914 | .... |
| Total private | 2,688 | 8,866 | 799 | 2,304 | 1,829 | 1,123 | 17,609 | 39,803 | 252 |
| **January, 1933 (4 weeks)** | **6,106** | **27,353** | **6,343** | **8,640** | **10,453** | **36,497** | **95,392** | .... | **802** |
| December, 1932 (5 weeks) | 2,880 | 36,147 | 15,012 | 17,020 | 16,927 | 15,324 | 103,360 | .... | 2,971 |
| January, 1932 (4 weeks) | 6,305 | 44,349 | 5,465 | 13,107 | 13,191 | 11,164 | .... | 93,581 | 5,237 |



month output had increased to 17 per cent and during the last week of January had risen to 19 per cent of capacity. In the Chicago district production rose from 14 per cent to 18 per cent of capacity during the last week of the month. Structural steel fabricators in the Pittsburgh area are reported to be operating at a fair rate. Activity is increasing in the Youngstown area with additional blast furnaces and rolling mills expected to resume operation shortly. Prices of steel products were disturbed by unofficial reductions in wire products including nails. Bars are holding steady at $1.60 per 100, but reports are current that price concessions are being made on structural shapes and plates.

### Labor notes

Estimates of the American Federation of Labor place the number of unemployed at the beginning of the year close to 12,000,000. President William Green of the Federation declares, however, that unemployment is increasing less rapidly at this time than in any other depression year.

*Washington, D. C.*—The five-day strike by hoisting engineers on the new post office department building, which threw 600 men out of work, was called off Jan. 25, although the dispute causing the strike was not settled. The hoisting engineers claim they should operate the motor generator sets supplying welding current used by steam fitters. The steam fitters claim that it was their privilege to operate the generators, inasmuch as the current was being used on their work.

*Dallas*—Union carpenters in Dallas have agreed to take a 50 per cent reduction in wage scales on all repair and remodeling work started between Jan. 1 and March 1. The regular scale is $8 per day, reduced from $10 a year ago. The move has the endorsement of the Modernization Campaign and Better Homes Exposition, and it is hoped to provide much-needed work for a large number of carpenters out of jobs.

*New York State*—According to the New York State Department of Labor, the number of applicants for every 100 positions offered by employers during December was 442.8, a considerable drop from the November index of 502.3.

*New Jersey*—The state highway commission has decided to stagger employment rather than dismiss 500 employees at this time, as some such drastic action is necessary under reduced operating budgets. Jacob L. Bauer, chief engineer, has been instructed to present a schedule making possible the staggering of time.

*Rochester, N. Y.*—A 20 per cent reduction in wages for building mechanics was announced on Jan. 16 by leading Rochester contractors. Building trades employees threatened to strike, but comparatively few men would be involved as very little work is under way at present in the city. New scales announced are: painters, 80c.; carpenters, 80c.; bricklayers, $1. An agreement with the unions which expired Dec. 31 has not been renewed.

*California*—Holding that the Metropolitan Water District of Southern California had not exercised judicial function in fixing the prevailing wage scale for labor on the Colorado River aqueduct project and was within its jurisdiction, the Los Angeles County superior court has sustained the demurrer petition of representatives of certain classes of labor for a writ of review of the district's action. The court's decision resulted in a dismissal of the petition. The petitioners had asserted that the district had set lower wages for its workers on the project than those in the locality along the route of the aqueduct.

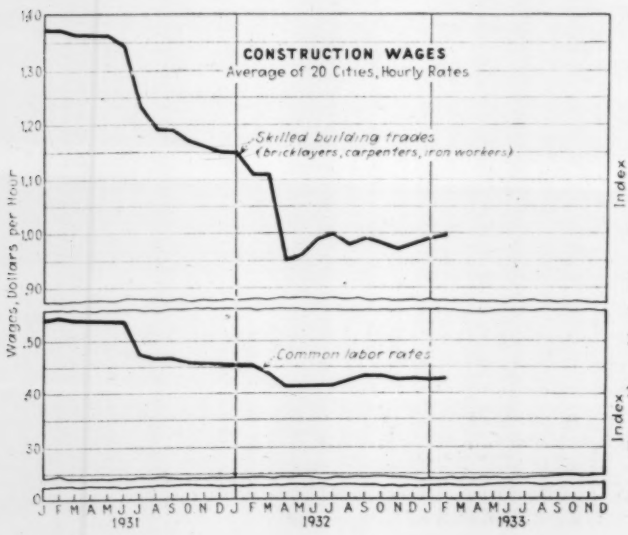
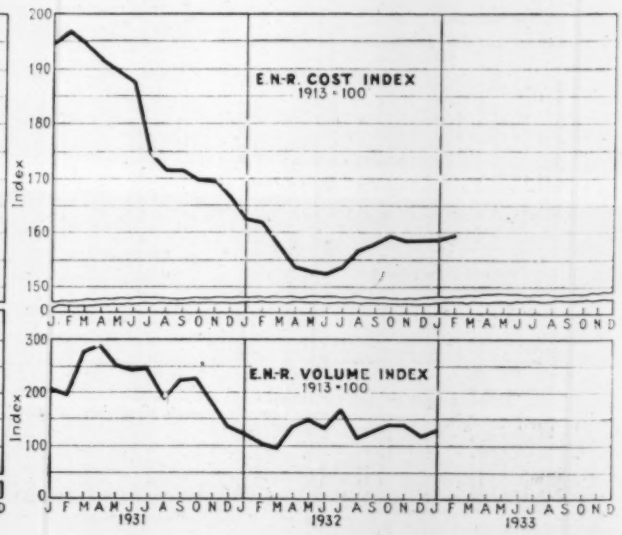
*New Orleans*—Labor to be employed on the proposed New Orleans bridge will be paid the rates prevailing in the city, it was announced following a conference between city officials and the bridge contractors.

CURRENT BUILDING AND CONSTRUCTION TRADES WAGE RATES PER HOUR

| Cities | Bricklayers | Carpenters | Hoisting Engineers | Pile Drivers | Structural Iron Workers | Masons' Laborers | Common Laborers |
|---|---|---|---|---|---|---|---|
| Atlanta | $0.75@1.12½ | $0.40@.90 | $0.60@1.25 | ..... | $0.60@1.25 | $0.25 | $0.20@.25 |
| Baltimore | .62½@1.00 | .65@.90 | 1.37½ | $0.65 | 1.25 | .40 | .30 |
| Birmingham | .75@.87½ | .60 | .75 | ..... | .75 | .25 | .20@.30 |
| Boston | .90@1.30 | .70@1.17½ | 1.00@1.17½ | .70@1.07½ | 1.00@1.20 | .45@.70 | .40@.70 |
| Cincinnati | 1.27½ | 1.02½ | 1.07½ | 1.07½ | 1.20 | .70 | .40@.45 |
| Chicago | 1.37½ | 1.31¼ | 1.31¼ | 1.31¼ | 1.35 | .82½ | .50@.82 |
| Cleveland | .90@1.37½ | .75@1.12½ | .90@1.12½ | 1.00 | .90@1.06¼ | .56¼ | .30@.72 |
| Dallas | .62½ | .50 | .50 | .50 | .50 | .25 | .25@.35 |
| Denver | 1.00@1.12½ | .75@.87½ | .75@.87½ | ..... | .75@.87½ | .50 | .31¼@.50 |
| Detroit | .75@1.50 | .55@.80 | 1.25 | 1.25 | 1.25 | .70 | .30@.50 |
| Kansas City | 1.30 | 1.12½ | 1.12½ | 1.06 | 1.12½ | .75 | .35@.50 |
| Los Angeles | .62½ | .50 | .75 | .75 | .75 | .50 | .35@.50 |
| Minneapolis | .90@1.00 | .75 | .75 | ..... | .90 | .50 | .40@.50 |
| New Orleans | 1.00 | .75 | 1.00 | .70 | 1.25 | .25@.40 | .15@.25 |
| New York | 1.50@1.65 | 1.25@1.40 | 1.50@1.65 | 1.50 | 1.65 | .81¼@1.00 | .50@.75 |
| Philadelphia | .75@1.00 | .50@.75 | .75@1.00 | .60@.75 | .75@1.00 | .20@.35 | .15@.25 |
| Pittsburgh | .60@1.50 | .60@1.25 | .60@1.37½ | 1.00@1.18¾ | .60@1.37½ | .50 | .40@.70 |
| St. Louis | 1.50 | 1.25 | 1.35@1.47 | 1.25 | 1.47 | 1.00 | .35@.78¾ |
| San Francisco | 1.12½ | .90 | 1.00 | 1.00 | 1.20 | .75 | .65 |
| Seattle | .75@1.20 | .50@.90 | 1.00 | .90 | 1.10 | .66 | .40@.50 |
| Montreal | .75 | .60 | .55 | ..... | .70 | .45 | .25@.30 |

Skilled Average (3 trades) .996. Common Average, .429.

## *ENR* Cost and Volume Index

The *ENR* cost index for February is 159.30, an increase over the January index of 158.44. The increase was due mostly to the $1 rise in the lumber item entering into the make-up of the index. This is the highest the cost index has been since February, 1932, when it was 161.82. The lowest point in 16 years was reached last June when the index stood at 152.20. The *ENR* volume index for January is 129, as compared with 113 for December, 1932. A year ago the volume index was 121.

| E.N.-R. Cost | | E.N.-R. Volume | |
|---|---|---|---|
| **February, 1933** | **159.30** | **January, 1933** | **129** |
| January, 1933 | 158.44 | December, 1932 | 113 |
| February, 1932 | 161.82 | January, 1932 | 121 |
| 1932 (Average) | 156.97 | 1932 (Average) | 127 |
| 1931 (Average) | 181.35 | 1931 (Average) | 220 |
| 1930 (Average) | 202.35 | 1930 (Average) | 260 |
| | | 1913 Average | 100 |